# Iron and Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

10 EMPIRE BUILDING | AUGUST, 1945 | PITTSBURGH, PA.

Mesta 18"—14" Merchant Mills with Pack Annealing Cooling Bed and Equipment

Army-Navy "E" Flag with five stars for the Mesta Plant

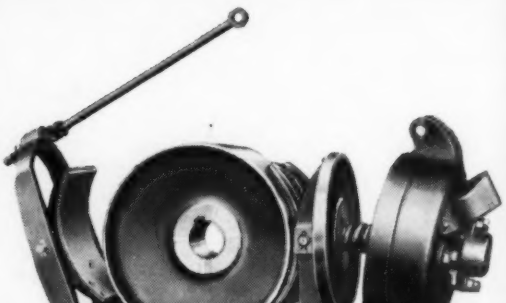
ARMY E NAVY

Rolling Stock for 90-mm. Anti-Aircraft Shells at KAISER COMPANY, Inc.
IRON AND STEEL DIV., FONTANA, CALIF.

MESTA MACHINE CO.
PITTSBURGH, PA.

# THE BRAKE THAT HAS STOOD THE TEST OF TIME

Cutler-Hammer engineers, long versed in mill requirements, designed the C-H Type M Brake with those specific needs in mind. With braking essentials concentrated into a few rugged parts, the C-H Type M Brake is simplicity itself; yet endowed with all the durability demanded by heavy duty operations. So dependable and efficient has been its performance that the C-H Type M Brake has never relinquished its preferred position anywhere. This matchless record is but another tribute to the engineering skill that has made the name Cutler-Hammer world-famous . . . another reason why discriminating users of electrical equipment today insist on Cutler-Hammer Brakes for each and every heavy duty installation. CUTLER-HAMMER, Inc., 1269 St. Paul Ave., Milwaukee 1, Wisconsin. Associate: Canadian Cutler-Hammer, Ltd., Toronto, Ont.



**Power transmitted in a straight line is power at its greatest efficiency**

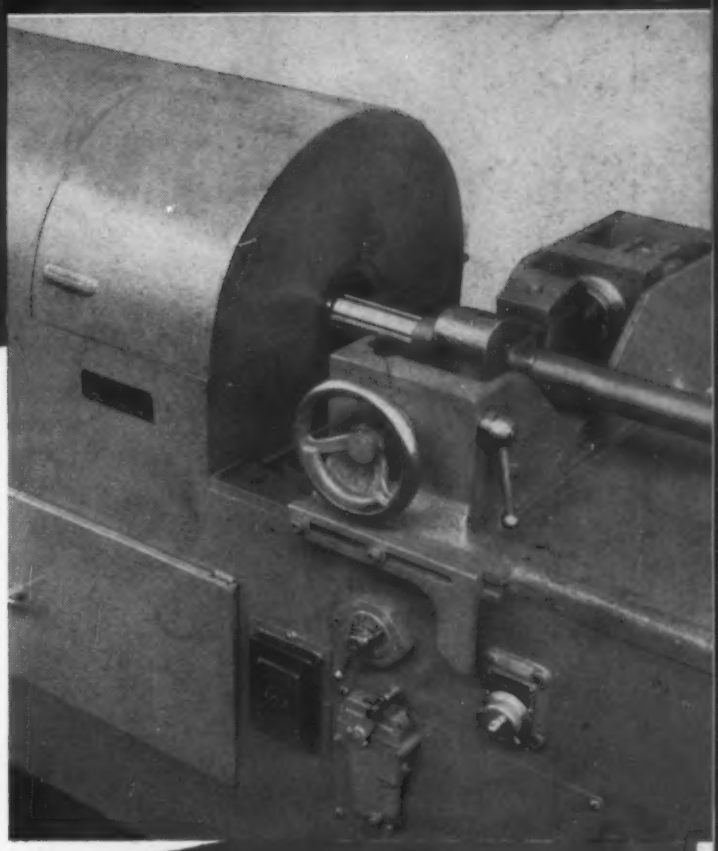
Exploded view of C-H Type M Magnetic Brake shows simplicity of design, ruggedness of parts and directness of power application.

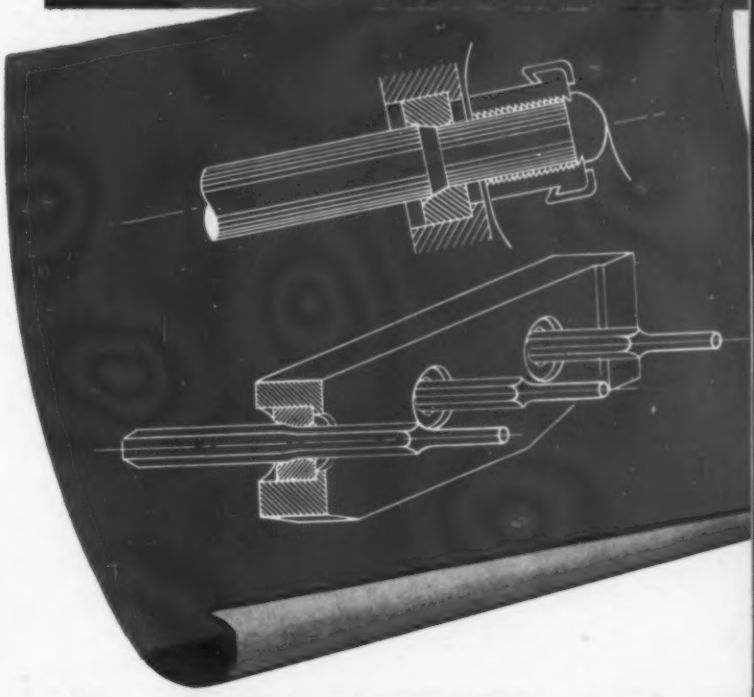
CUTLER-HAMMER
MOTOR CONTROL
C-H

ANOTHER ADVANCED FEATURE
*by* AETNA-STANDARD

# BAR TURNING POINTER

*with Automatic Hydraulic Feed*





Here's a profitable answer to pointing bars.

The operator rolls a bar into position, presses a button, and the machine takes over. The bar is clamped into position, fed into the revolving cutters at the proper speed, reversed and unclamped . . . *all automatically.*

Maintenance and operating men like the modern design and compactness. The unit requires only a minimum of floor space and all mechanical assemblies are easily accessible. No "hard-to-get-at" places to plague maintenance crews. Cutters of the universal chuck adjust simultaneously, permitting easy adjustment for size. The push button control can be placed in any convenient location.

This new machine points ferrous and non-ferrous bars up to and including 4½". Aetna-Standard makes other types of pointers for pointing any size bar or tube, light wall, heavy wall, small or large diameters. Aetna also designs and manufactures all sizes and types of drawbenches and accessory equipment.

Write for engineering data on turning pointers or other cold drawing equipment.

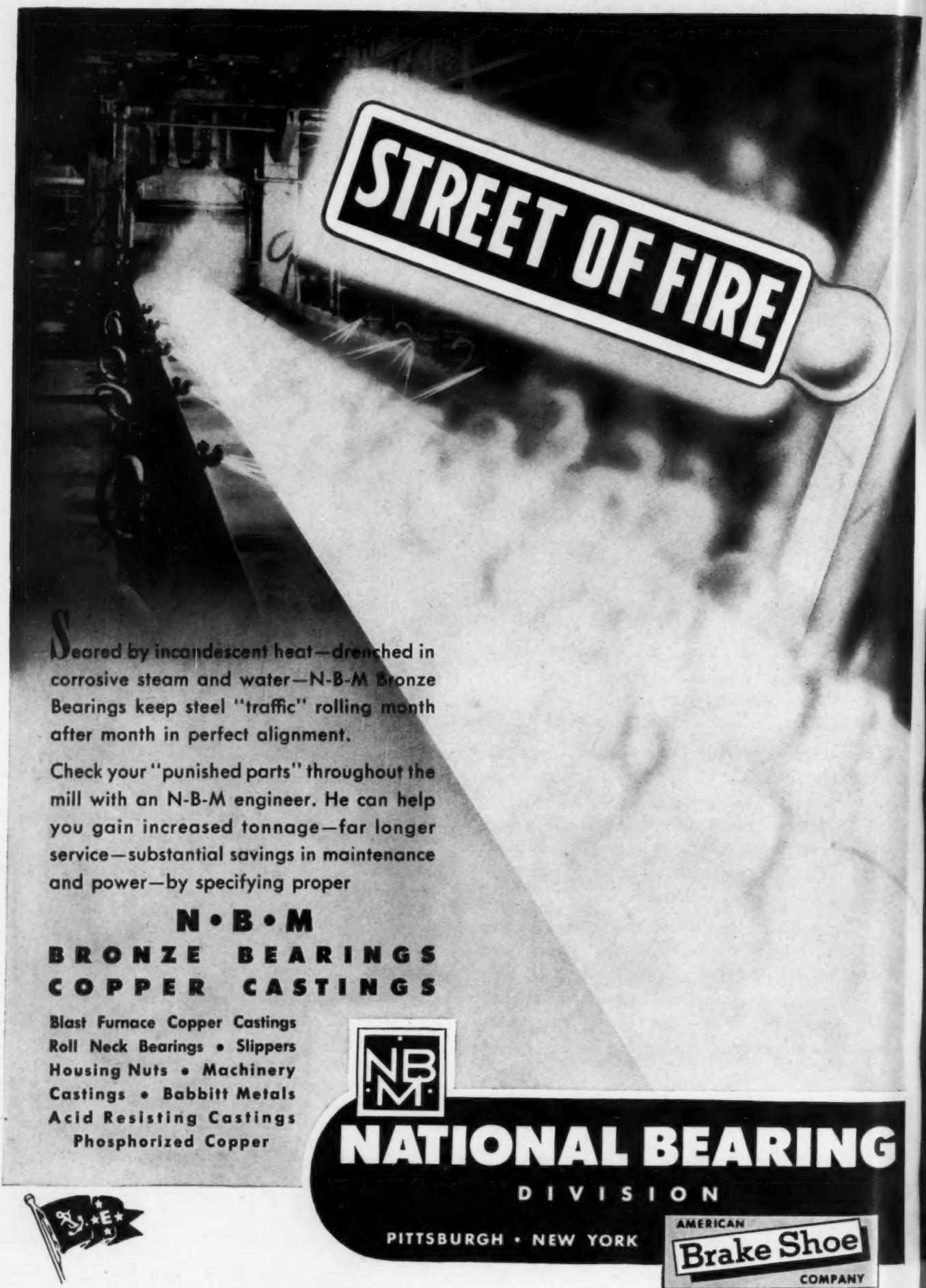
**THE AETNA-STANDARD ENGINEERING COMPANY**

YOUNGSTOWN, OHIO

DESIGNERS AND BUILDERS to the Steel, Non-Ferrous and Chemical Industries.

*ASSOCIATED COMPANIES:*

HEAD, WRIGHTSON & COMPANY, LIMITED, THORNABY-ON-TEES, ENGLAND
JOHN INGLIS COMPANY, LIMITED, TORONTO, ONTARIO, CANADA




Seared by incandescent heat—drenched in corrosive steam and water—N-B-M Bronze Bearings keep steel "traffic" rolling month after month in perfect alignment.

Check your "punished parts" throughout the mill with an N-B-M engineer. He can help you gain increased tonnage—far longer service—substantial savings in maintenance and power—by specifying proper

**N • B • M**

**BRONZE BEARINGS**
**COPPER CASTINGS**

Blast Furnace Copper Castings
Roll Neck Bearings • Slippers
Housing Nuts • Machinery
Castings • Babbitt Metals
Acid Resisting Castings
Phosphorized Copper

N.B.M.

**NATIONAL BEARING**
DIVISION
PITTSBURGH • NEW YORK

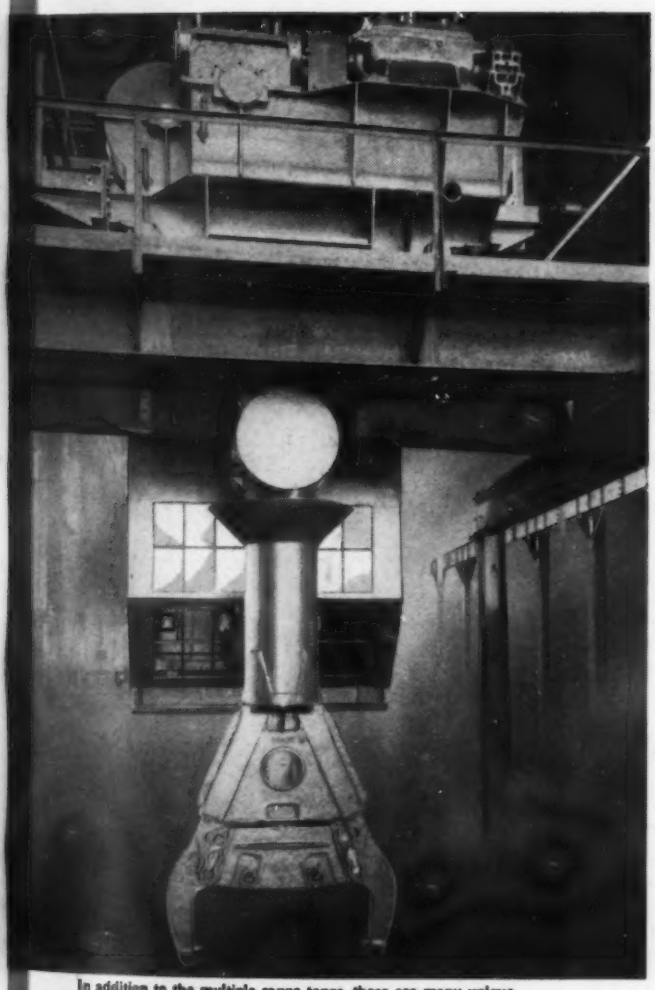
AMERICAN Brake Shoe COMPANY

PLANTS IN: ST. LOUIS, MO. • PITTSBURGH, PA. • MEADVILLE, PA. • JERSEY CITY, N. J. • PORTSMOUTH, VA. • ST. PAUL, MINN. • CHICAGO, ILL.

HERE'S SOMETHING *NEW* IN SOAKING PIT CRANES . . .

# multiple range tongs

ARMY E NAVY



In addition to the multiple range tongs, there are many unique features on this new soaking pit crane, designed by Alliance.

The multiple range tongs, designed and patented by Alliance, represent an advancement in soaking pit crane design.

Alliance developed these new tongs to overcome the troublesome problem of charging and drawing many different size slab ingots with the same crane.

The tongs on this crane are fundamentally different from tongs on conventional soaking pit cranes. By means of an ingenious locking pin, the tongs can be adjusted, *in less than a minute,* to any one of four positions, providing a wide size spread:

> Position (1) takes care of ingots up to 10" x 22"; position (2) — 18" x 40"; position (3) — 36" x 52"; and position (4) — 48" x 60".

Since size adjustments can be made quickly and easily, an operator can handle many more ingots in a given time. By gripping the slabs on the edges, bit marks are eliminated from the rolling surface.

The tongs have the same operating characteristics as a standard soaking pit crane. Consequently, Alliance can install the multiple range tongs *on any existing soaking pit crane, regardless of make.*

As world's largest builders of the world's largest cranes, Alliance has come up with many firsts in crane designing, such as the 4 girder interlocking drum ladle crane, the intensified grip soaking pit crane, and the combination push-pull stripper. The multiple range tongs represent another Alliance first.

We will be glad to discuss this new crane development with you.

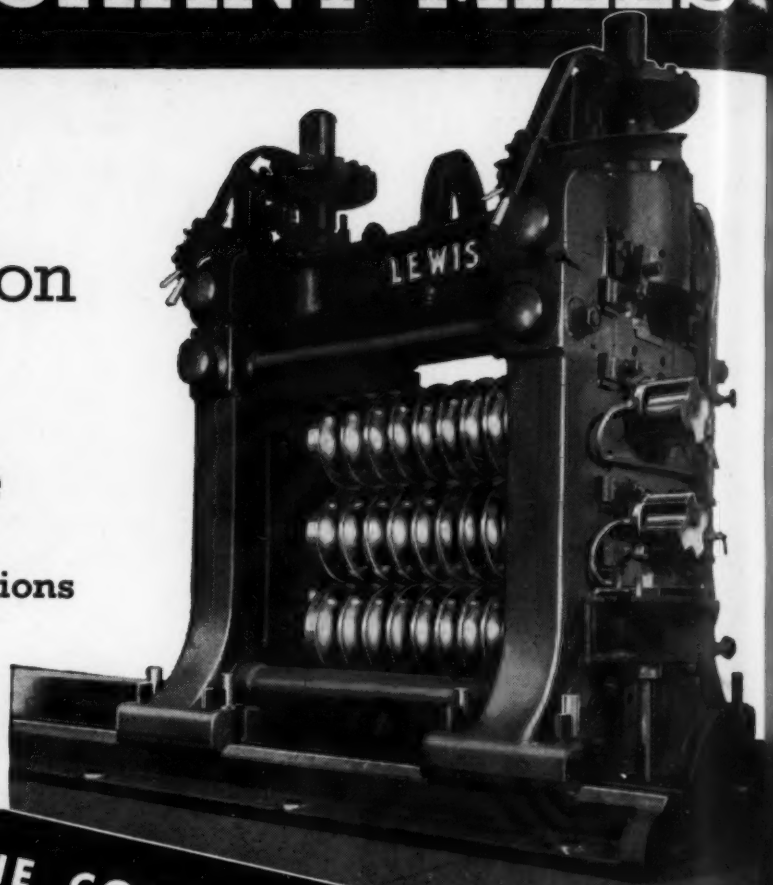
THE ALLIANCE MACHINE COMPANY • ALLIANCE, OHIO

PITTSBURGH OFFICE : 1622 OLIVER BUILDING

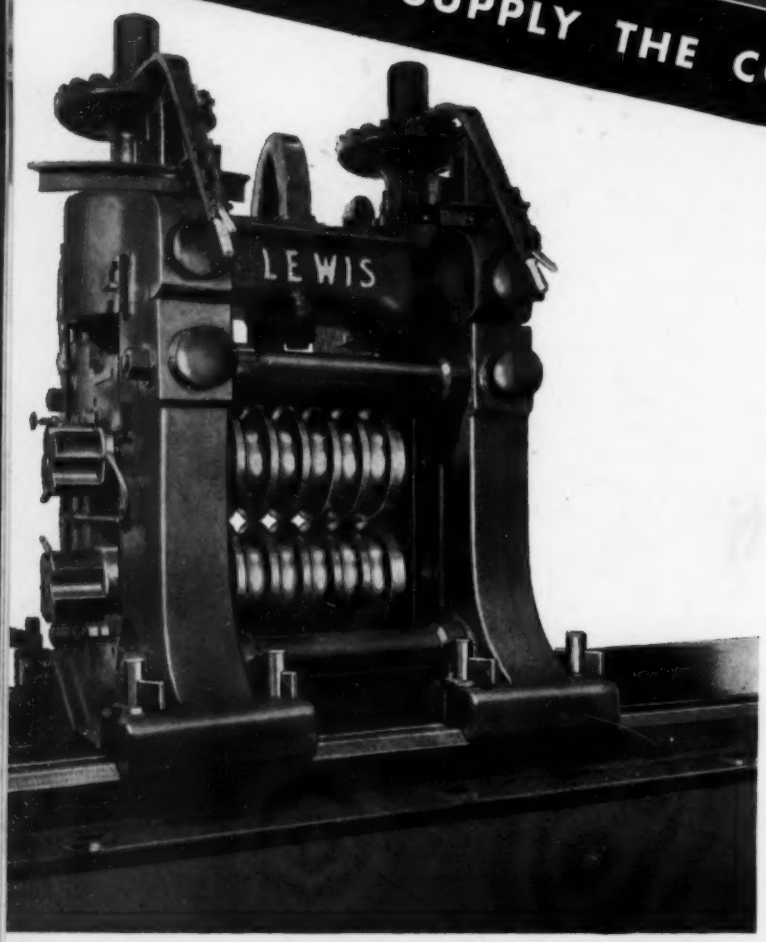
# LEWIS MERCHANT MILLS

## Latest Design
## Heavy Construction
## Low Upkeep
## Superior Tonnage

**Built to meet your special conditions**




**LEWIS WILL SUPPLY THE COMPLETE MILL** FROM FURNACE TABLES TO LOADING PLATFORMS




**Conveyor Tables**

**Tilt or Travelling Tables**

**Shears and Gauges • 3 Hi Mills**

**2 Hi Mills • Manipulators • Transfers**

**Straighteners • Gag Presses**

**Hot Saws • Coilers • Cooling Beds**

ARMY E NAVY

LEWIS

## LEWIS FOUNDRY & MACHINE

DIVISION OF BLAW-KNOX CO.

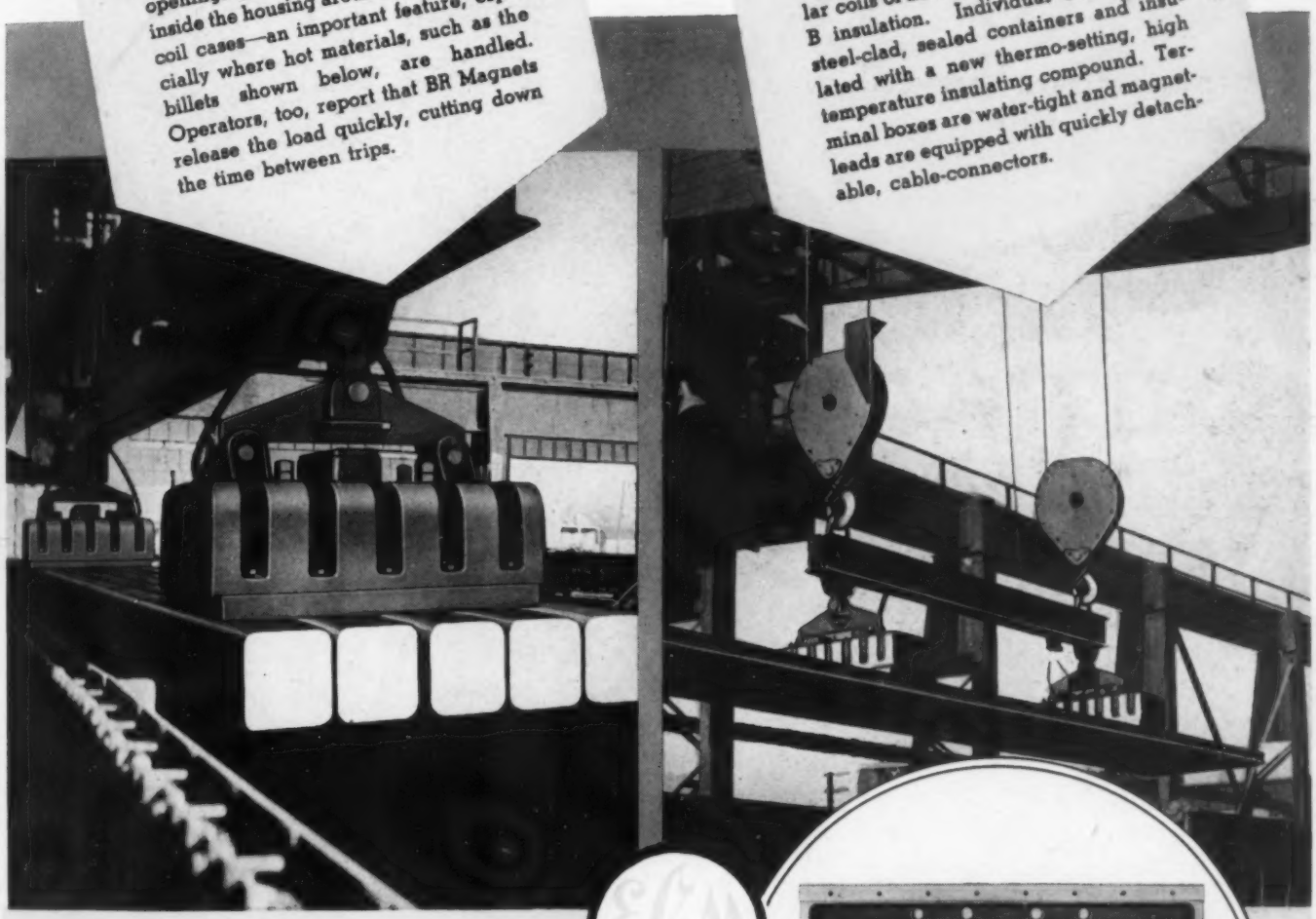
PITTSBURGH, PA.

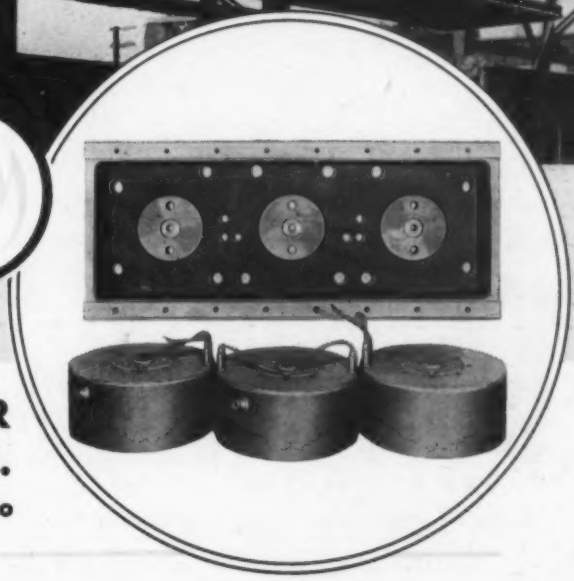
# *Improved* BILLET and RAIL HANDLING with EC&M "BR" MAGNETS

These are heavy-duty magnets designed especially for handling rails, billets, bars, pipe, structural shapes, etc. Usually they are worked in pairs, being suspended by their suspension yoke from a spreader-bar and operated in parallel from one controller. For single magnet installation, chain suspension is standard.

Magnet-housings have ventilating openings in the top and both sides. These openings permit free circulation of air inside the housing around the individual coil cases—an important feature, especially where hot materials, such as the billets shown below, are handled. Operators, too, report that BR Magnets release the load quickly, cutting down the time between trips.

The design of these Type BR Magnets departs radically from the conventional in that, instead of a single (or perhaps two) oblong coils, these BR Magnets are fitted with several tightly wound, circular coils of bare strap copper with Class B insulation. Individual coils are in steel-clad, sealed containers and insulated with a new thermo-setting, high temperature insulating compound. Terminal boxes are water-tight and magnet-leads are equipped with quickly detachable, cable-connectors.





*Above:* Pair of No. 2 Type BR Magnets with five billets for deposit into annealing box.

*Upper Right:* Pair of No. 3 Type BR Magnets lifting single layer of rails—also used for handling double locked layer of rails.

*Lower Right:* Pre-assembly view showing how circular coils are keyed and bolted to No. 3 BR Magnet Housing.

**THE ELECTRIC CONTROLLER AND MANUFACTURING CO.**

**2698 East 79th Street** **Cleveland 4, Ohio**

# ANYONE MAY OBTAIN A LICENSE TO USE UNIONMELT Welding

*Licenses may be obtained from:*

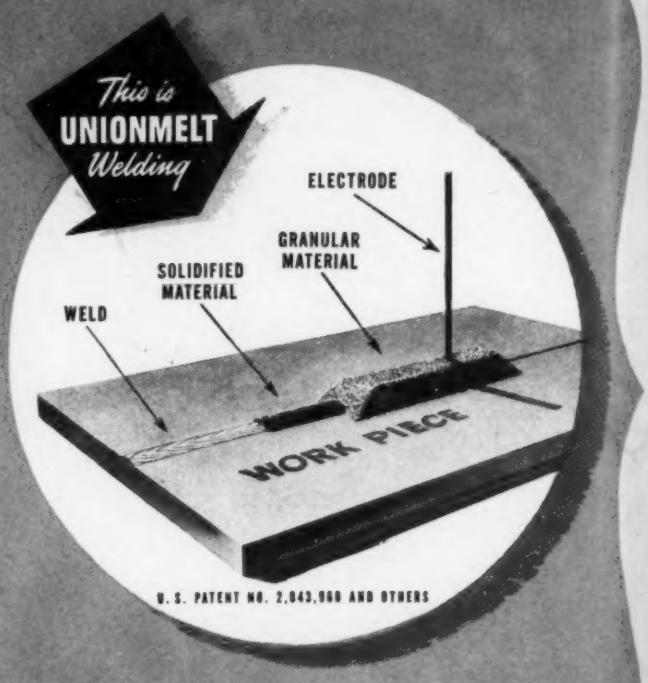
THE LINDE AIR PRODUCTS COMPANY

•

*There are hundreds of licensees*

AMONG WHOM ARE:

- Automobile Manufacturers
- Wheel Manufacturers
- Aircraft Manufacturers
- Shipbuilders and Ship Repairers
- Railroad Equipment Builders
- Chain Manufacturers
- Manufacturers of Pressure Vessels
- Manufacturers of Pipe and Tubes
- Structural Steel Fabricators
- Machinery Manufacturers
- Household Equipment Manufacturers




*A process of welding electrically beneath a mineral melt*

. . . and successful producers of other things as widely varied as airplane propellers, tanks, gun mounts, blowers, chemical plant equipment, conveyor screws, and sheet metal parts.

UNIONMELT welding is electric welding done as diagrammed above. It makes top quality welds at speeds that are greater than with any other similarly applicable process.

Anyone who wishes to use this patented invention may do so under our standard license agreement. License fees are low and based upon extent of use. Complete engineering assistance is available to licensees.

For additional information send for "Report No. 6 on the Use of Linde Methods in Mass Production" or ask a Linde representative to help you determine where you can use the UNIONMELT process advantageously.

MARITIME "M" AWARD FOR OUTSTANDING PRODUCTION ACHIEVEMENT

## THE LINDE AIR PRODUCTS COMPANY

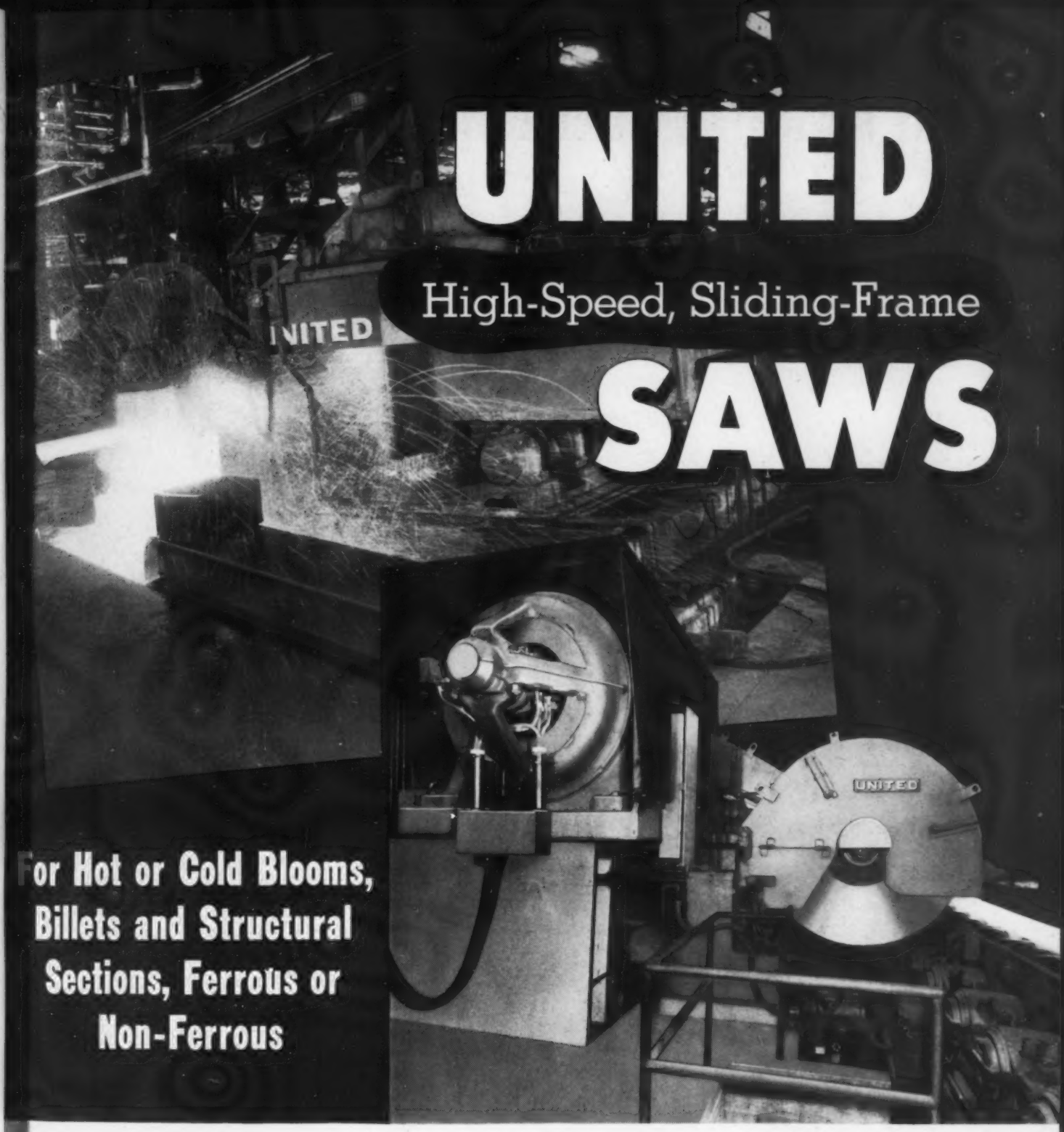
*Unit of Union Carbide and Carbon Corporation*

30 E. 42nd St., New York 17, N. Y. UCC Offices in Other Principal Cities

In Canada: Dominion Oxygen Company, Limited, Toronto

The word "Unionmelt" is a registered trade-mark of The Linde Air Products Company

★ BUY UNITED STATES WAR BONDS AND STAMPS ★




# UNITED

## High-Speed, Sliding-Frame

# SAWS

**For Hot or Cold Blooms, Billets and Structural Sections, Ferrous or Non-Ferrous**

As in other steel processing equipment, UNITED has pioneered in the development of *high-speed saws* of various types for cropping, or cutting to marketable lengths, all sizes of hot or cold billets, blooms, and structural sections. The fact that 95 UNITED *High-Speed, Sliding-Frame Saws* are in present use in ferrous and non-ferrous plants throughout the world, testifies to the industry's marked preference for them where dependable, heavy-duty service is required.

For complete technical information and recommendations for your specific need, consult UNITED engineers.

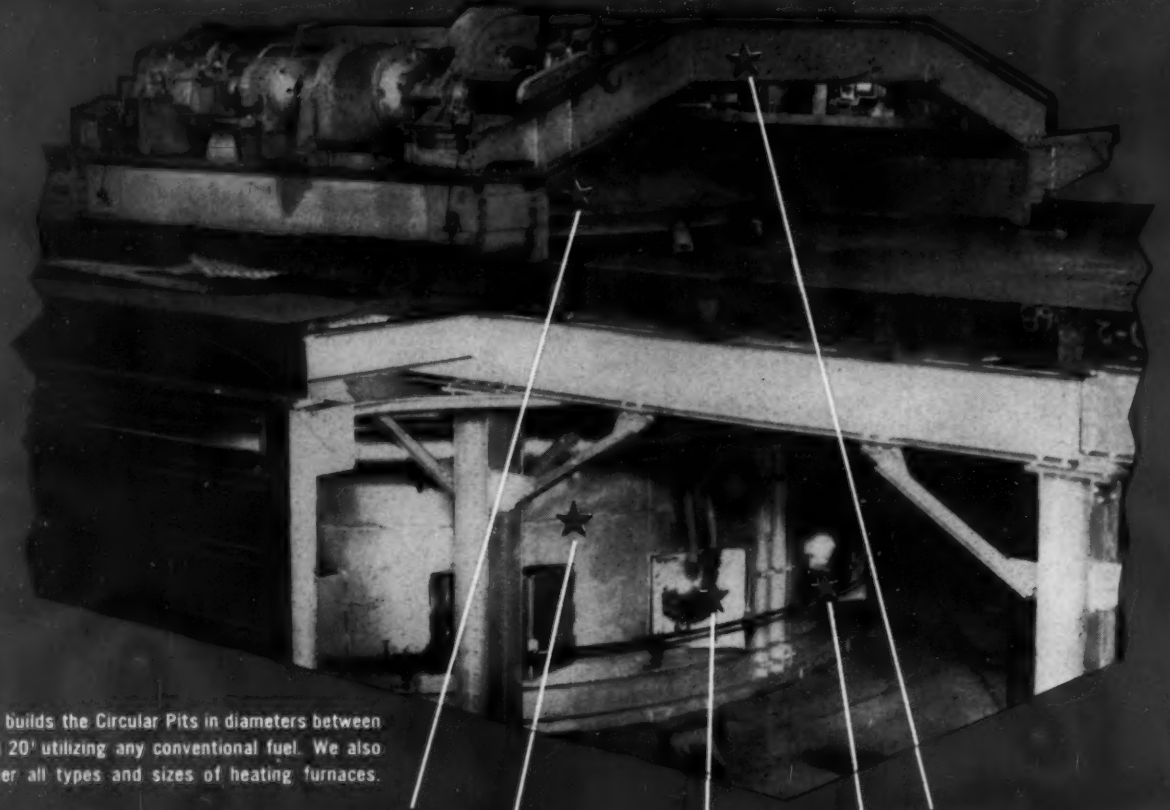
**UNITED ENGINEERING AND FOUNDRY COMPANY**
**PITTSBURGH, PENNSYLVANIA**
**Plants at PITTSBURGH • VANDERGRIFT • NEW CASTLE • YOUNGSTOWN • CANTON**
**Subsidiary: Adamson United Company, Akron, Ohio**
**Affiliates: Davy and United Engineering Company, Ltd., Sheffield, England**
**Dominion Engineering Works, Ltd., Montreal, P. Q. Canada**

REG. T.M.

** The World's Largest Designers and Makers of Rolls and Rolling Mill Equipment*

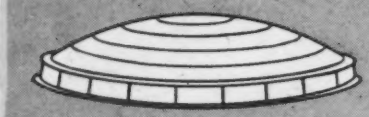
*here's why operating men prefer*

# SALEM CIRCULAR SOAKING PITS



alem builds the Circular Pits in diameters between
and 20' utilizing any conventional fuel. We also
ngineer all types and sizes of heating furnaces.

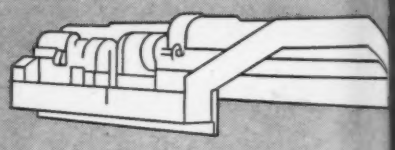
## BEST COVER ON ANY PIT



Less spalling because the cover dissipates heat slowly when off the pit.

These and many more features make the Salem Circular Soaking Pit popular with the men who know . . . Pit Man, Roller, and Superintendent. Ask for Detailed Information based on your heating requirements.

## SPECIAL COVER CRANE



Toggle type lifting mechanism raises cover out of seal and transverse drive unit moves cover to side One crane can serve as many as five pits

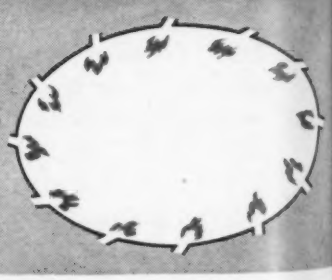
## NO CHECKERWORK

The Salem Circular Pit has no expensive arches or checkerwork to replace.

## FAST HEATING TIME

Heat is applied to the bottom of the ingot where it can be absorbed in a minimum of time.

## MULTIPLE BURNERS



By using multiple burners, the heat diffusion through a furnace can be almost perfect. Multiple burners equally spaced around the circumference, give a perfectly balanced heat treating furnace for ingots

# SALEM ENGINEERING CO. · SALEM, OHIO

*"Engineered Heat"*

## New patented Gargoyle Grease Sovarex L . . .

# CUSHIONS BACK-UP ROLLS

## UNDER HEAVIEST PRESSURES!

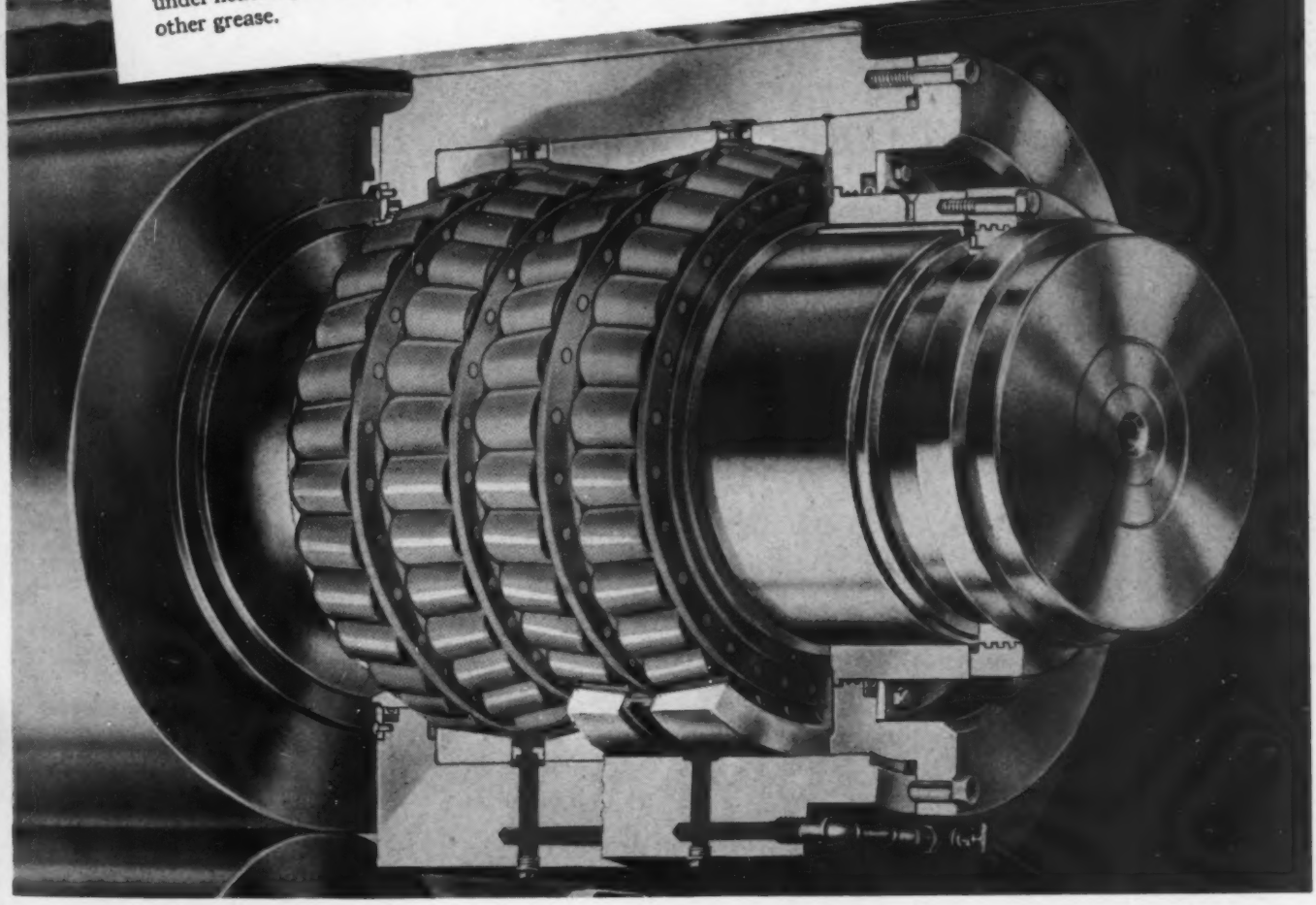
NO NEED to tell a steel man about the terrific pressures on this back-up roll. You know from experience the need for a lubricant that can take these pressures, and protect those roller bearings.

Here's the answer—Gargoyle Grease Sovarex L—now in use in many steel mills, stands up under heavier pressures than any other grease.

On work rolls and table rolls, as well as on back-up rolls, this new patented Socony-Vacuum lubricant not only cushions against shock loads, but also resists softening under high-temperatures. Equally important, it sticks on under the washing effect of water, assists mechanical devices in maintaining a seal against leakage.

Get performance facts and figures from your Socony-Vacuum Representative. Then get Gargoyle Grease Sovarex L, for the best protection you can buy for your vital rolling mill equipment.

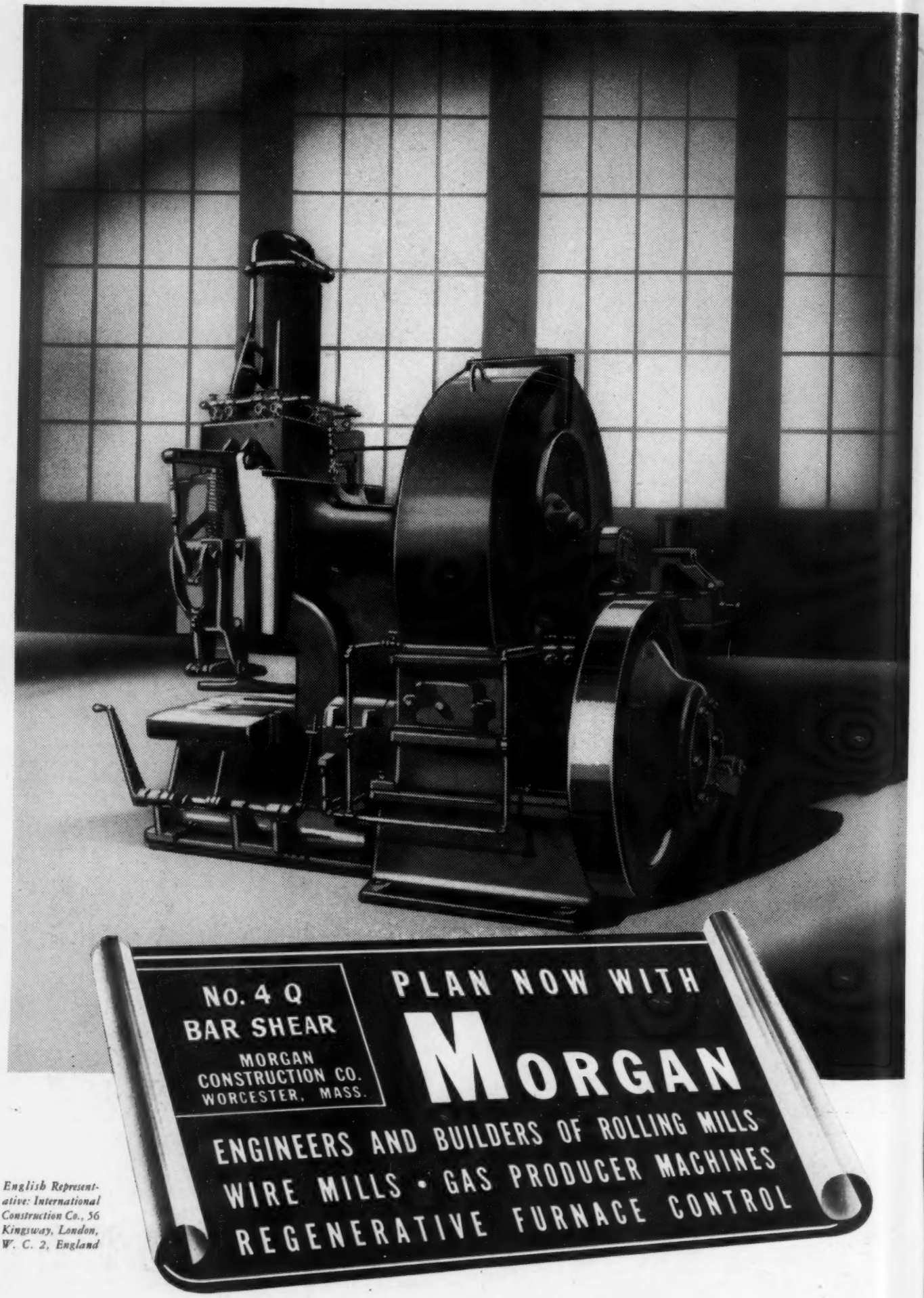
SOCONY-VACUUM OIL CO., INC. Standard Oil of N. Y. Div. · White Star Div. · Lubrite Div. · Chicago Div. · White Eagle Div. · Wadhams Div. · Magnolia Petroleum Co. · General Petroleum Corp. of Calif.



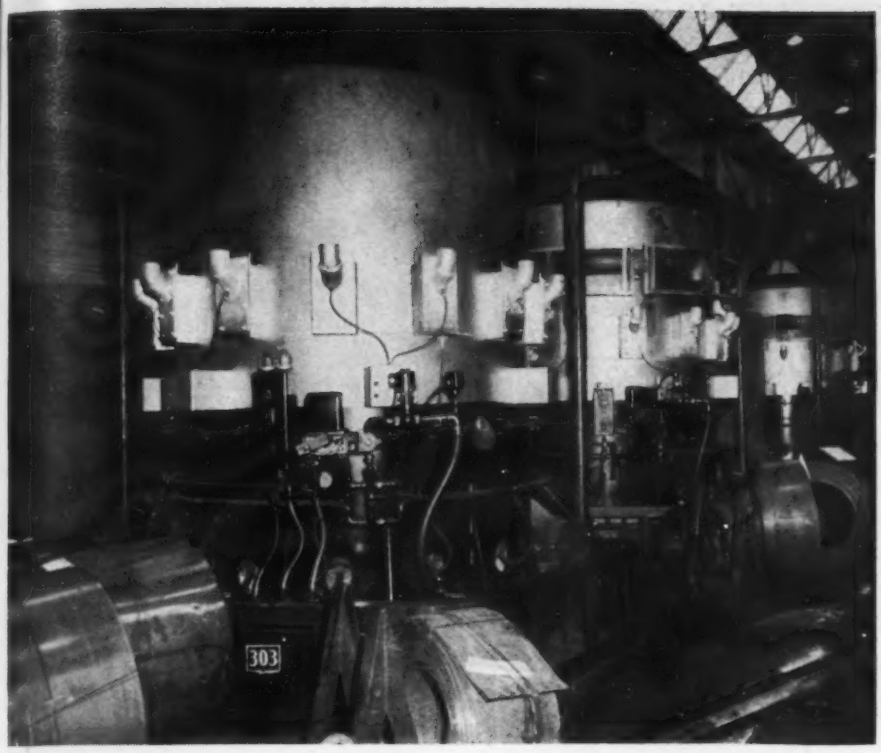
GARGOYLE Lubricants

SOCONY-VACUUM'S 5 Steps to Lower Production Costs:

1. Lubrication Study of Your Entire Plant
2. Lubrication Schedules and Controls
3. Lubricant Storage and Handling System
4. Skilled Engineering Counsel
5. Progress Reports of Benefits Secured




*English Representative: International Construction Co., 56 Kingsway, London, W. C. 2, England*



Three of a large battery of Wilson radiant-tube cover furnaces in which temperatures are controlled by the arrangement of Micromax Pyrometers described herein. A Micromax Control Electric-Drive Unit may be seen on the front of each cover; some of the Controllers are shown below.

# SATISFYING STEEL-FURNACE NEEDS WITH MICROMAX PYROMETERS

Heat-treatment of steel strip, in coils, is the job of the battery of cover-furnaces, shown above, in an Ohio steel mill. These furnaces are capable of extremely heavy production, and among the factors which make this possible is the use of Micromax Control, shown in the lower picture. These are especially designed to give full responsiveness, in handling the coils, with their high heat capacity.

*The equipment includes Micromax strip-chart Recording Controllers, and their own type of electric valve-drives. The regulating action proportions the fuel to the load's needs — is floating or throttling, as distinguished from an on-off system. And the regulation is based on two thermocouples — one located to detect the temperature of the furnace's radiant tubes; the other to detect the surface of the coils of strip. Both couples are permanently connected to the Controller.*

While the furnace is coming up to soak temperature, the Controller regulates on the basis of the couple at the tubes. But, when the coils are at temperature, the control shifts automatically to the other couple, against the strip. Thus, while the heating-up is going on, the tremendous heat capacity of the charge can't lead the Controller to send fuel so fast that the relatively low-capacity cover is damaged; and when the shoe is on the other foot, and the charge is soaking, the Controller can consult the charge itself in supplying heat necessary to maintain temperature. At all times, the micro-responsiveness of the Micromax enables it to head off the small changes before they become large, and so hold temperature uniform.

*Many hundreds of big-furnace installations and many thousands of men in big steel-mill jobs have made Micromax the Pyrometer for the really tough, really responsible jobs of automatic temperature control. For Micromax, with the qualities which all pyrometers have to some extent, has those qualities to an advanced degree, by the way in which it is designed and made. And these qualities are applied with full effectiveness in any temperature-controlling situation . . . If you have a temperature-control problem, anywhere in a metal-refining or metal-working plant, outline it to us and an L&N engineer will either make a specific control-pyrometer recommendation, or send you the appropriate general catalog — as you wish.*

Foreman examines Micromax Recording Controllers for the furnaces pictured at top of page

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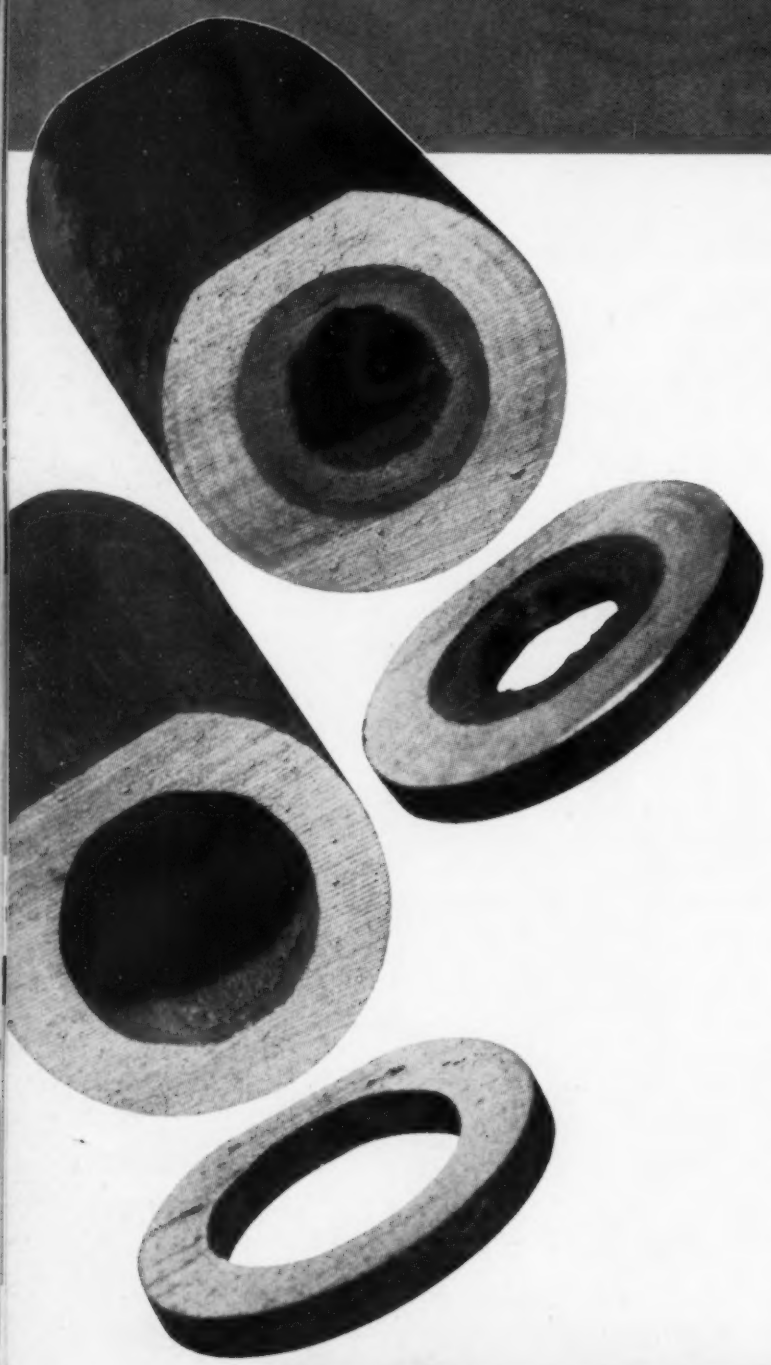
depends on me!
A Slogan For Every American

LEEDS & NORTHRUP COMPANY, 4942 STENTON AVE., PHILA., PA.
LEEDS & NORTHRUP
MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

# Another beautiful theory **wrecked** by a ruthless fact



**THE THEORY:**

*Water circulating in pipes which are exposed to extremely high temperatures cannot be successfully treated to inhibit scale and corrosion.*

**THE FACT:**

## Calgon* does it!

Here's the evidence—an eight-month test made in a steel mill reheating furnace, where heavy billets are subjected to a temperature of 2100°F. before rolling.

The billets are pushed through these furnaces on water cooled "skid pipes." When the pipes begin to buckle, they must be replaced at once—and this has been a frequent occurrence because of scale for-

HAGAN
HALL
BUROMIN
CALGON

**calgon, inc.**

A SUBSIDIARY OF
HAGAN CORPORATION

HAGAN BUILDING
PITTSBURGH 30, PA.

mation and corrosion caused by the cooling water.

It had been generally accepted that nothing could be done about this situation—that such high external temperatures meant proportionately high skin temperatures and hence that no known water treatment would be effective.

The photographs show what Calgon actually did. Each section of pipe was in service approximately eight months, but water circulating through the pipe at the top was untreated, while that through the pipe at the bottom had been treated with Calgon.

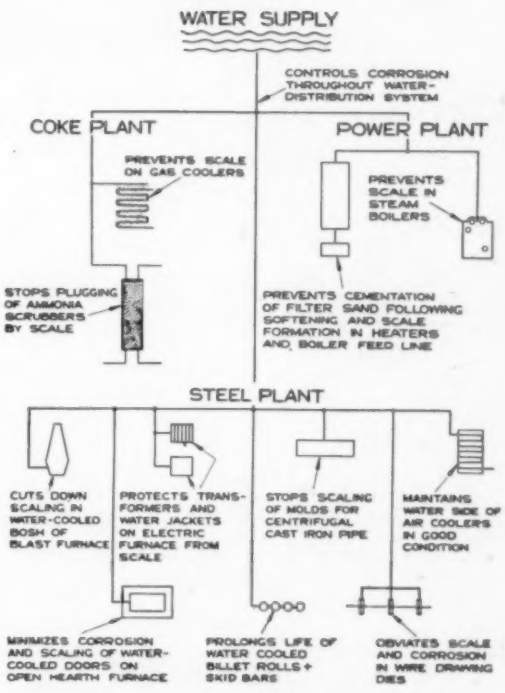
Scale choked the opening of the top pipe and decreased the flow of water to a point where the cooling effect was inadequate.

Calgon-treated water has kept the other pipe as free from scale as the day it was installed. At the same time it has protected the bare pipe surface from corrosion.

As the chart at the right shows, use in skid pipes is only one of the many applications of Calgon to water conditioning in the iron and steel industry. Let us send you full information.

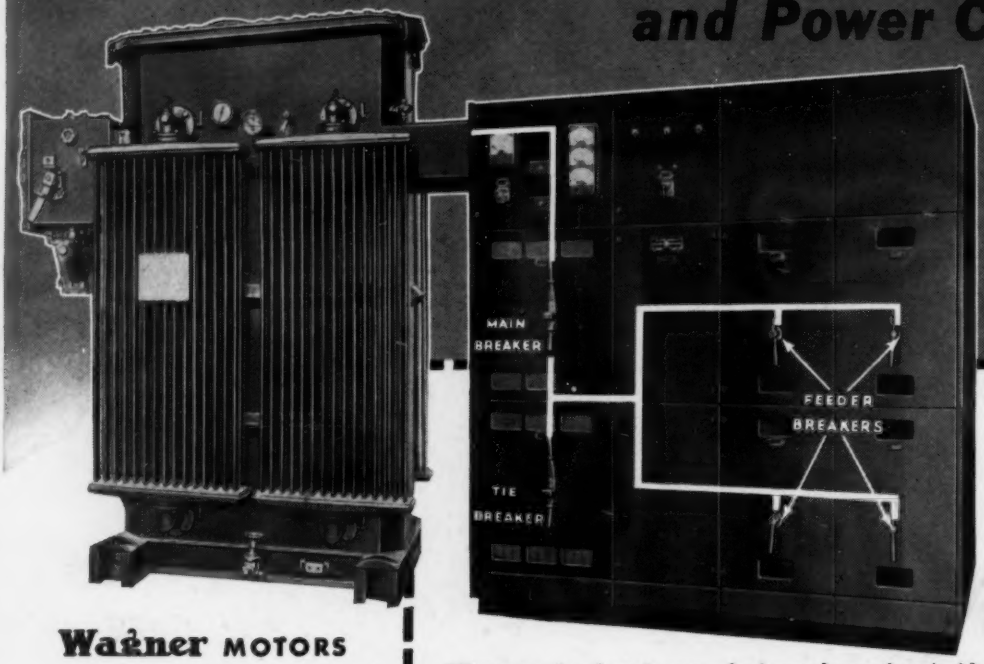
** Calgon is the registered trade-mark of Calgon, Inc. for its glassy sodium phosphate products.*

## SPECIFIC APPLICATIONS OF CALGON TO WATER CONDITIONING IN THE IRON AND STEEL INDUSTRY


WATER SUPPLY
CONTROLS CORROSION THROUGHOUT WATER-DISTRIBUTION SYSTEM
COKE PLANT
POWER PLANT
PREVENTS SCALE ON GAS COOLERS
PREVENTS SCALE IN STEAM BOILERS
STOPS PLUGGING OF AMMONIA SCRUBBERS BY SCALE
PREVENTS CEMENTATION OF FILTER SAND FOLLOWING SOFTENING AND SCALE FORMATION IN HEATERS AND BOILER FEED LINE
STEEL PLANT
CUTS DOWN SCALING IN WATER-COOLED BOSH OF BLAST FURNACE
PROTECTS TRANSFORMERS AND WATER JACKETS ON ELECTRIC FURNACE FROM SCALE
STOPS SCALING OF MOLDS FOR CENTRIFUGAL CAST IRON PIPE
MAINTAINS WATER SIDE OF AIR COOLERS IN GOOD CONDITION
MINIMIZES CORROSION AND SCALING OF WATER-COOLED DOORS ON OPEN HEARTH FURNACE
PROLONGS LIFE OF WATER COOLED BILLET ROLLS + SKID BARS
OBVIATES SCALE AND CORROSION IN WIRE DRAWING DIES

# Wagner
## UNIT SUBSTATIONS

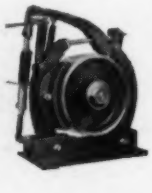
## Provide Load Center Control for Lighting and Power Circuits...




### Wagner MOTORS

There is a Wagner motor to fit every job. Our line is complete from small fractional-horsepower fan-type motors to large 400-horsepower motors used in heavy industries.

### Wagner INDUSTRIAL HYDRAULIC BRAKES



Wagner Industrial Hydraulic Brakes are of two types: without parking brake (Type H) and with parking brake (Type HM). These braking systems provide quick, safe, smooth stops with the operator in complete and accurate control.

### THESE BRANCHES ARE READY TO SERVE YOU

ATLANTA • BALTIMORE • BOSTON • BUFFALO • CHICAGO • CINCINNATI • CLEVELAND • DALLAS • DENVER • DETROIT HOUSTON • INDIANAPOLIS • KANSAS CITY LOS ANGELES • MEMPHIS • MILWAUKEE MINNEAPOLIS • NEW YORK • OMAHA PHILADELPHIA • PITTSBURGH • PORTLAND ST. LOUIS • SALT LAKE CITY • SAN FRANCISCO • SEATTLE • SYRACUSE • TULSA WASHINGTON, D. C.

Each of these offices is manned by trained field engineers. They will gladly consult with you regarding your transformer, motor, and brake requirements.

### Check THESE ADVANTAGES

Wagner unit substations can be located any place inside or outside your plant thus making it possible for you to determine the location of the load center placing it near the heavy load areas or power-using centers. Wagner unit substations combine one or more step-down transformers with the necessary load center for controlling the distribution power-circuits.

**1.** Saving of copper in connecting cables. Locating the transformer near the load allows the use of shorter and smaller cables over a great part of the distance the power must travel.

**2.** Improves performance of motors and lights. Inherent linedrop is avoided by eliminating long low-voltage feeders.

**3.** Can be installed indoors without the use of extensive fireproof vaults. The entire substation may be located on the floor in the open, saving construction time and material.

**4.** Simplifies installation. Complete substation is shipped in one or more factory-assembled units, completely wired, ready for installation and final connection.

**5.** Provides flexibility to meet future conditions. Compartments in the load centers are of such dimensions that interchangeable breakers of different interrupting ratings can be substituted should plant modifications bring about changes in feeder loads.

**6.** Low maintenance expense. The complete enclosing of the buses and other equipment practically eliminates cleaning and dust problems and assures safety against contact with live parts.

Illustrated above is a 1000-kva, 13,200-to 480-volt, 3-phase transformer with a two-position liquid-filled disconnecting switch on high-voltage side, key-interlocked with low-voltage breaker. The low-voltage side is equipped with air-break circuit-breakers manually operated, ground-indication lights, voltmeters, ammeters, ammeter switch, and test-blocks. Unit has one main breaker, one tie breaker, and four feeder breakers.

T45-17

## Wagner Electric Corporation

ESTABLISHED 1891

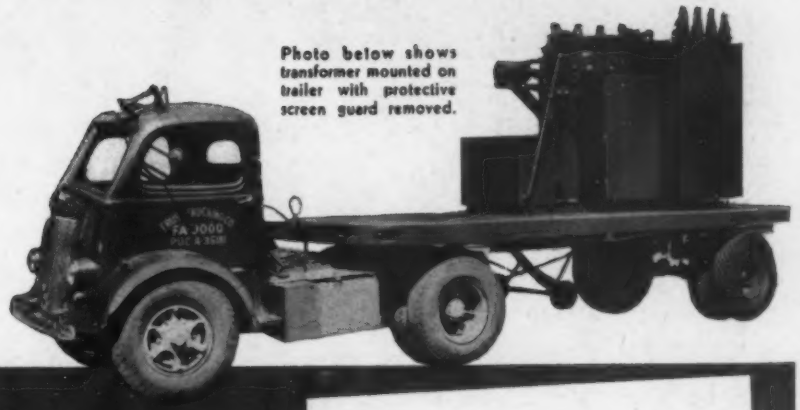
6483 Plymouth Avenue, St. Louis 14, Mo., U. S. A.

In Canada: Wagner Electric at Leaside, Ontario

ELECTRICAL AND AUTOMOTIVE PRODUCTS

# Pennsylvania PORTABLE Unit Substations

Photo below shows transformer mounted on trailer with protective screen guard removed.



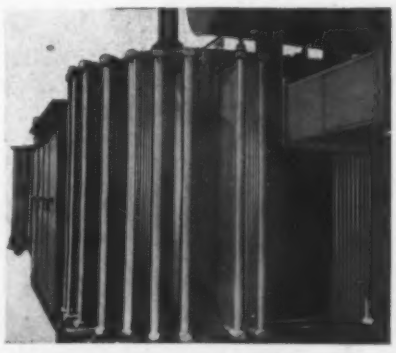
- ✓ PROVIDE EMERGENCY POWER
- ✓ RELIEVE OVERLOADED SUBSTATIONS
- ✓ REDUCE MAINTENANCE EXPENSE

Each unit is a fully equipped power substation, mounted on wheels, ready to roll at a moment's notice, to any point on the system where supplementary or temporary power is required. Extra capacity can be thus easily and quickly supplied to relieve overloaded substations or to furnish emergency power where permanent facilities are out of service. In addition to emergency and supplemental uses, Pennsylvania Portable Unit Substations can also carry the load of permanent facilities, temporarily, thus permitting maintenance at most convenient times. Overtime maintenance expense can be materially reduced as a result.

The Pennsylvania Portable Unit Substation, illustrated, is complete in every detail including a high voltage, oil-filled switch with a quick-break mechanism for making and breaking the magnetizing current; and a 50,000 Kva oil circuit breaker on the low side, with overcurrent protection. Auxiliary transformers, mounted in the main tank, furnish control power for operating the oil cooling pump and fan, and for closing and tripping the oil circuit breaker which is equipped with a solenoid-rectifier closing mechanism and capacitor trip. Forced oil cooling reduces size and weight to a minimum.

Write for full information.

**Pennsylvania Transformer Company also builds permanently installed Unit Substations**



Double Ended Unit Substation consisting of two 3750 Kva O.I.S.C., (5000 Kva forced air cooled) 3 phase, 12000 V.Y.—2400 V. delta transformer and 250,000 Kva outdoor metal clad switch gear.

Pennsylvania TRANSFORMER COMPANY
808 Ridge Avenue, N. S., Pittsburgh 12, Pa.

Pennsylvania TRANSFORMERS

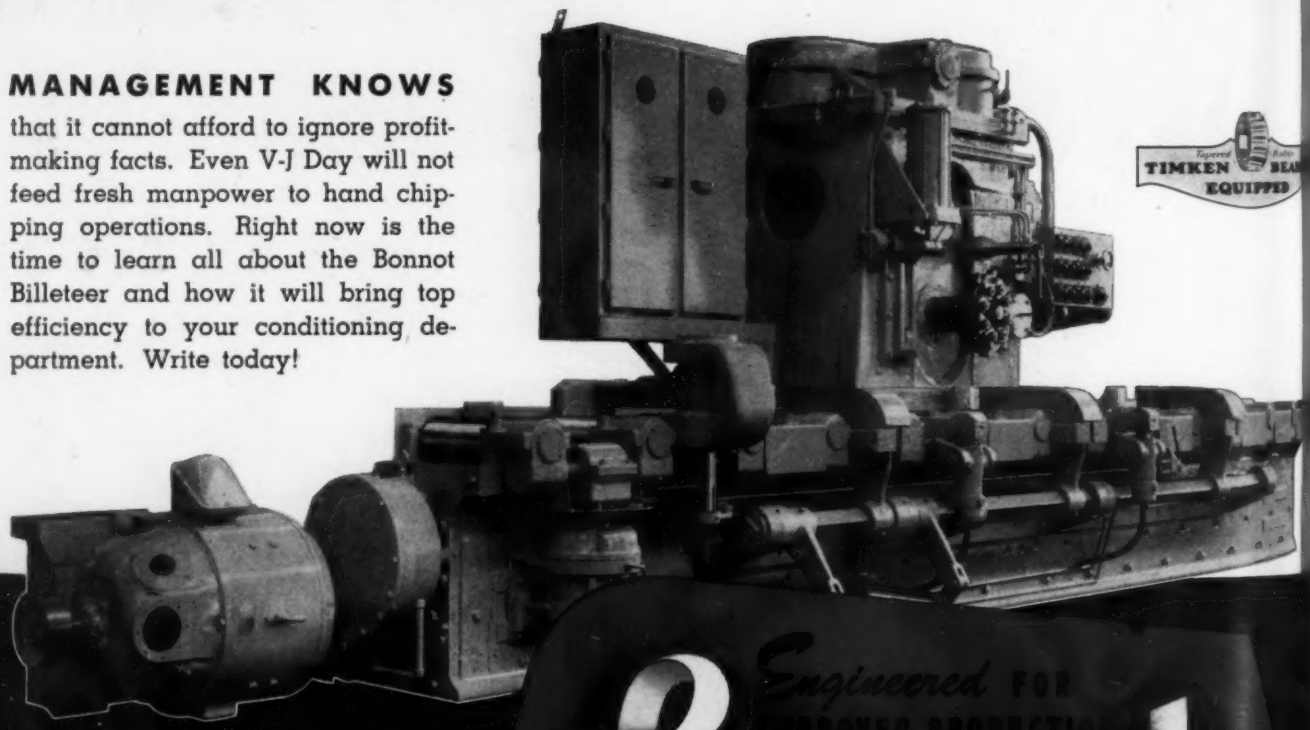
# 1 QUICKLY-TRAINED WORKER DOES THE JOB OF 10 MEN!

If a machine can free nine men out of ten for other operations, the worth of that machine is immediately evident. That is just what the BONNOT Billeteer does in conditioning steel billets.

In addition to the notable labor saving the Billeteer does the work more rapidly and efficiently than by the slow manual process. It also saves many billets lost because they require too much hand chipping. Another "bonus" given by the Billeteer is the saving of tons of scrap often lost in other conditioning.

**MANAGEMENT KNOWS**

that it cannot afford to ignore profit-making facts. Even V-J Day will not feed fresh manpower to hand chipping operations. Right now is the time to learn all about the Bonnot Billeteer and how it will bring top efficiency to your conditioning department. Write today!




MECHANIZE YOUR BILLET CONDITIONING NOW. PREPARE FOR TOMORROW'S INTENSIFIED COMPETITION.

*Engineered* FOR IMPROVED PRODUCTION

Bonnot

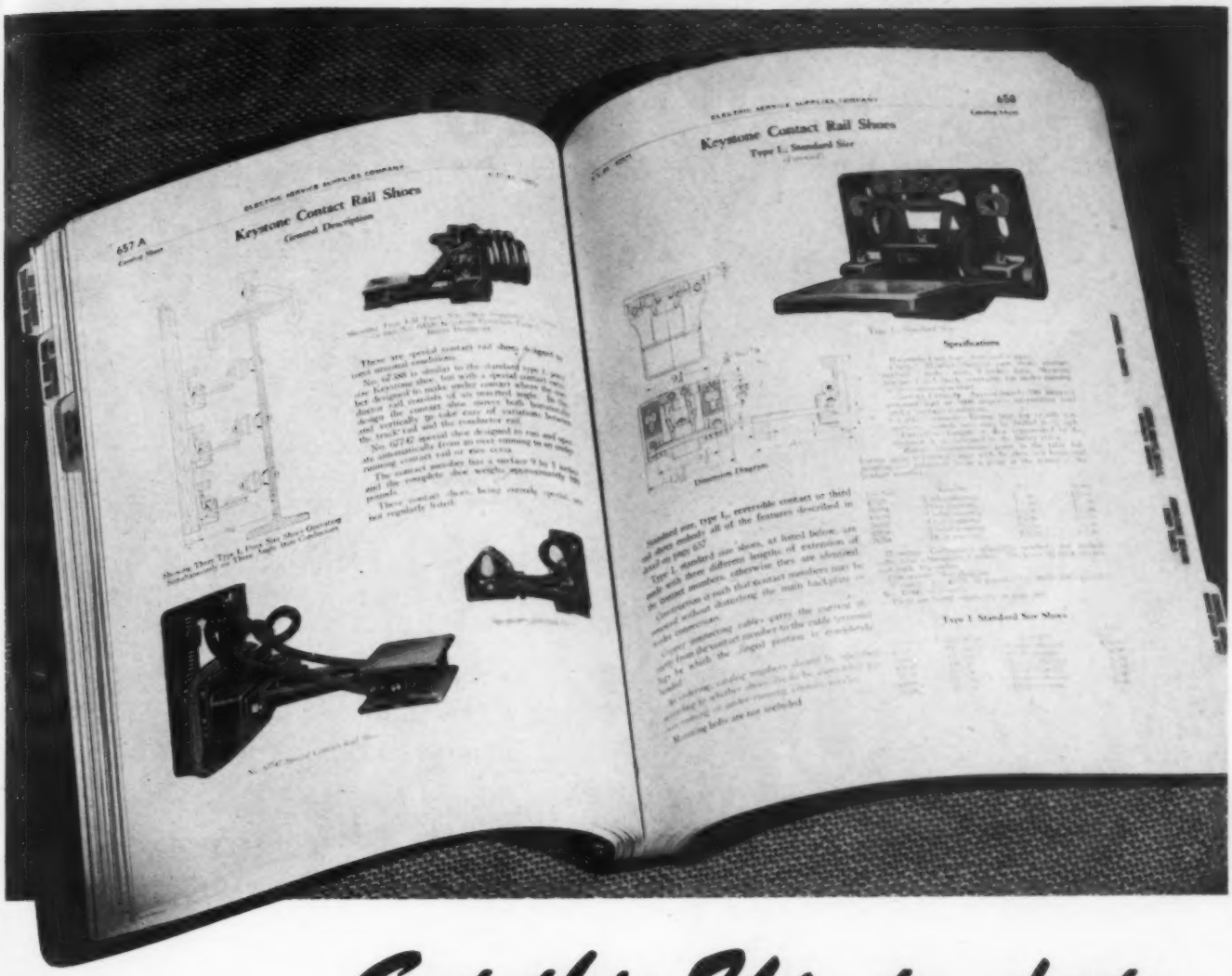
THE BONNOT COMPANY

*BUILDERS OF* **THE BILLETEER**

CANTON 2, OHIO

ADDRESS CORRESPONDENCE TO

STEEL EQUIPMENT DIVISION




# *Get this Up-to-date*

# KEYSTONE CATALOG!

**Engineering Headquarters for TRAVELING ELECTRICAL CONTACT and HEAVY FEEDER SYSTEM MATERIALS**

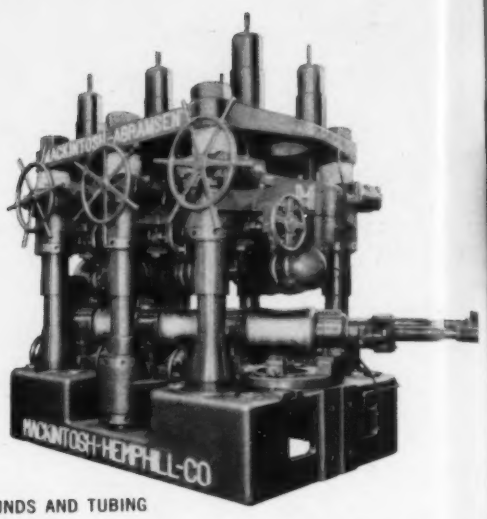
**This catalog will help you. Contains 500 pages listing hundreds of items necessary to construct and maintain electrical contacts on crane runways and electrical feeder systems. Ask for catalog "Keystone Electrical Material" if you do not have it in your files.**

## ELECTRIC SERVICE MANUFACTURING CO.

*Former Name—Electric Service Supplies Co.*

17th & CAMBRIA STREETS • PHILADELPHIA 32 • PA. • Branches in Principal Cities

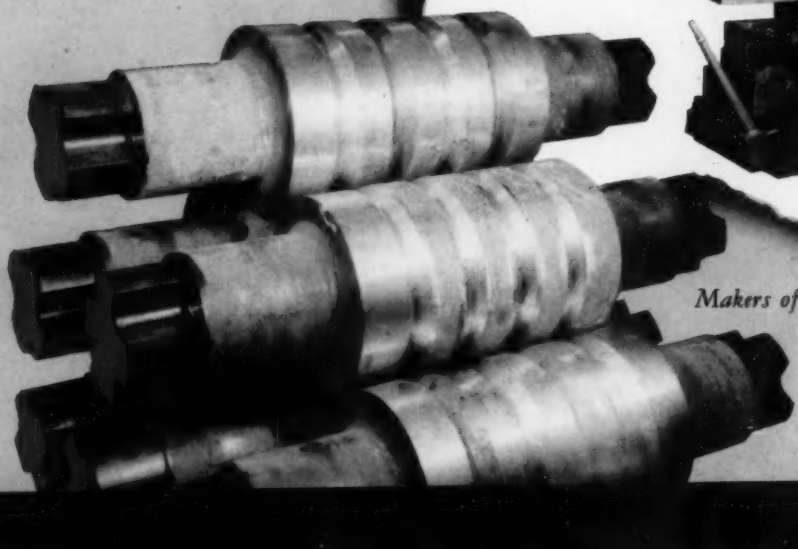
# These improved tools give you a vital advantage



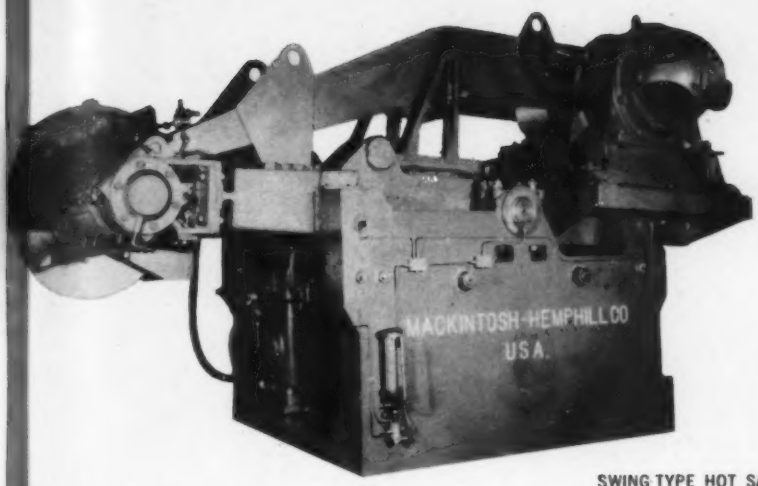

STRAIGHTENERS FOR ROUNDS AND TUBING

PRECISION MILLS
FOR ROUNDS AND SHAPES

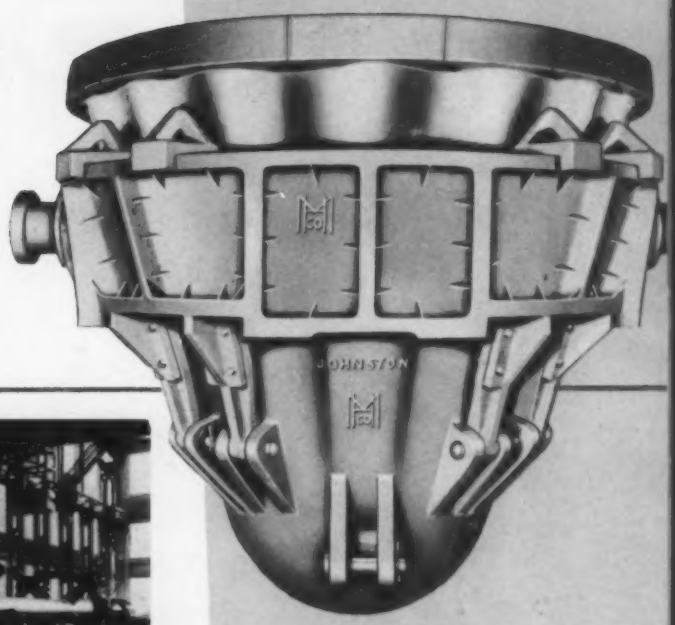
BAR, BILLET
AND SHAPE SHEARS



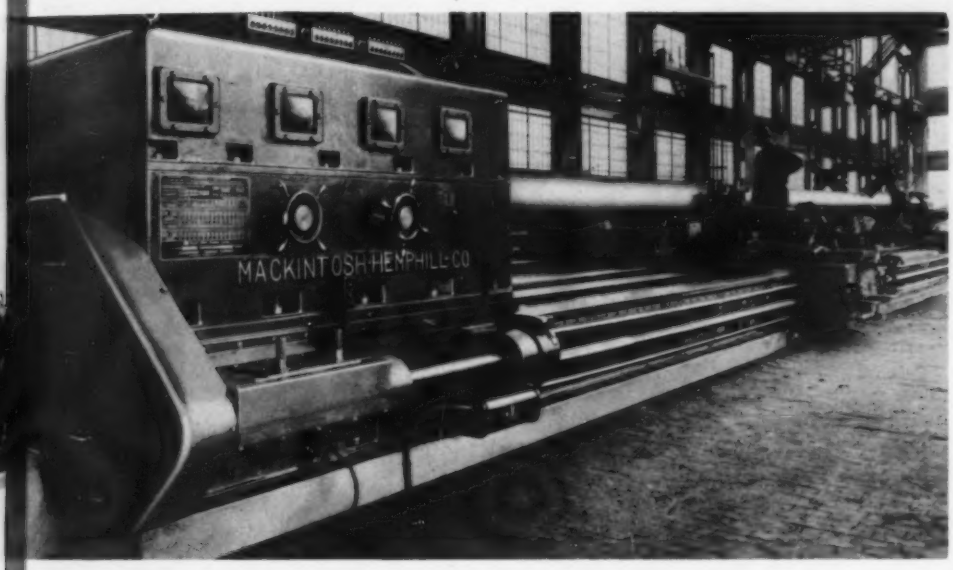
*Makers of the rolls with the red wa*




SWING TYPE HOT SAW




SLAG-HANDLING EQUIPMENT




HEAVY DUTY ENGINE LATHES

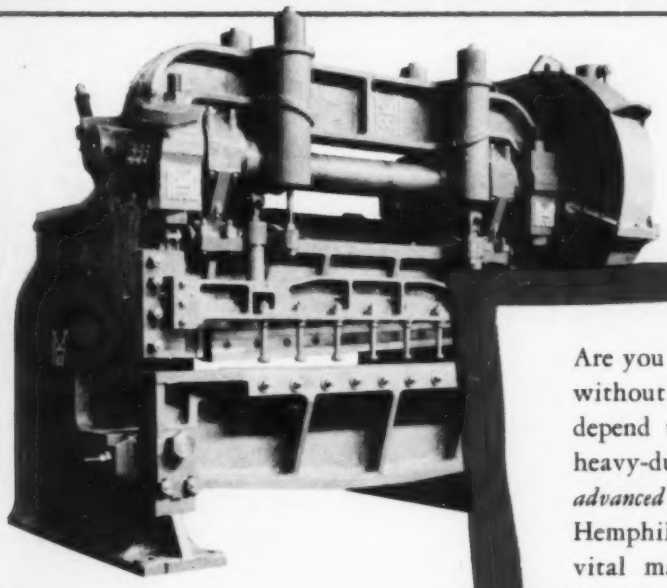


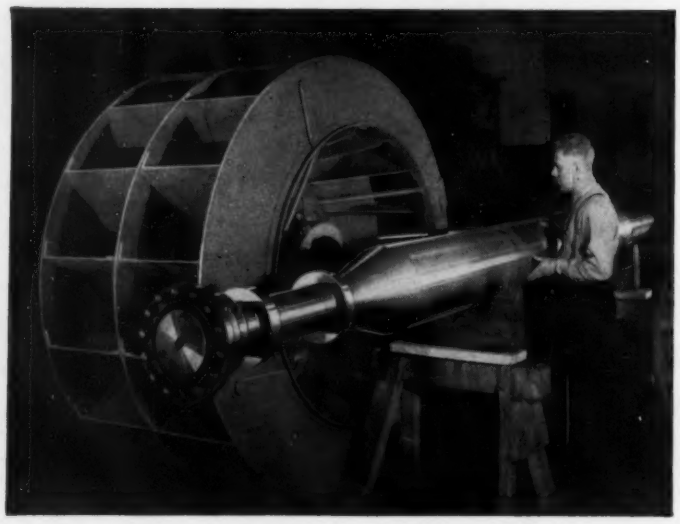
PLATE SHEARS

Are you prepared for stiffer competition? . . . It goes without saying that the future of your business will depend to a large extent on the efficiency of your heavy-duty equipment . . . Here's where you need *advanced industrial thinking*. Here's where Mackintosh-Hemphill's recent product improvements provide that vital marketing edge in reduced operating costs, higher quality production, faster output. Today, especially, it's important to remember that—"before you buy, check on what's new at Mack-Hemp."

**MACKINTOSH-HEMPHILL COMPANY, Pittsburgh and Midland, Pa.**

# CINDERS at Hurricane Speed pack a WALLOP

Huge "Buffalo" Induced Draft Fan ready to take years of punishment.



Mighty Rotor and Shaft of "Buffalo" Induced Draft Fan showing thick steel plates and blades.

## that's why "Buffalo"

## INDUCED DRAFT FANS are built to TAKE IT!

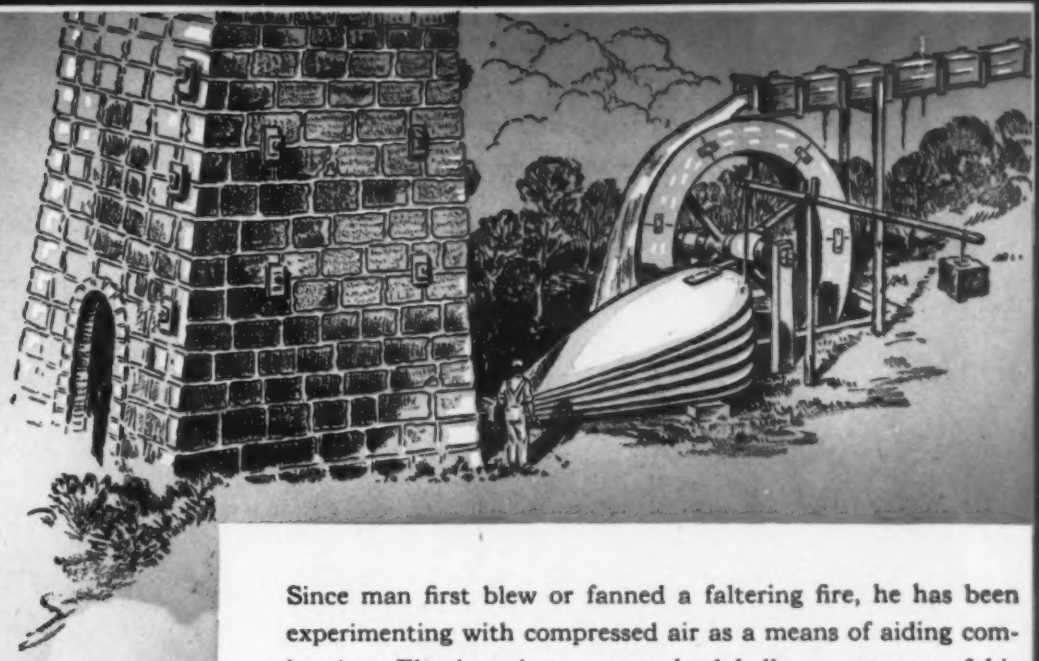
Drawing high-velocity storms of ashes from boiler fire beds year after year without let-up, Induced Draft Fans just *have* to be extra *tough* to stand the persistent erosion. That's why "Buffalo" rotors are designed with extra heavy blades and plates hot-riveted together for solid endurance . . . why they're designed to operate with MAXIMUM efficiency at moderate speeds for added years of practically attention-free service. When new rotors are finally necessary, "Buffalo" housings are easily "taken down" for speedy replacements! For complete description of "Buffalo" Induced Draft Fans, write for Bulletin 3190-B.

**BUFFALO FORGE COMPANY**

173 MORTIMER STREET BUFFALO, N. Y.

CANADIAN BLOWER & FORGE CO., LTD., KITCHENER, ONT.

"Buffalo" INDUCED DRAFT FANS



20 HP of water power converted to air power, based on sketches of a cold blast charcoal furnace worked in the early part of the 19th century. (From Two Centuries of Iron Smelting in Pennsylvania by Richard Peters, Jr.).

# *The* AIR ARM of INDUSTRY

Since man first blew or fanned a faltering fire, he has been experimenting with compressed air as a means of aiding combustion. The ingenious water-wheel bellows was one of his early efforts—one of many steps toward present day record-breaking production of metals.

Today it is the Turbo Blower that furnishes the air blast. These compact, centrifugal machines compress huge volumes of combustion air for the nation's furnaces and converters. Since 1913, when the first I-R Blast Furnace Turbo Blower was installed, Ingersoll-Rand has maintained its leadership in this field.

Other industries are using thousands of I-R Turbo Blowers for compressing air or gas for a multitude of purposes. Ingersoll-Rand's 30 years' experience in building blowers of all capacities totalling several million horsepower is back of the highly efficient designs available today in sizes of from 2 to 15,000 horsepower.

**Ingersoll-Rand**

11 Broadway, New York 4, N. Y.

CENTRIFUGAL PUMPS • CONDENSERS • COMPRESSORS • TURBO BLOWERS
ROCK DRILLS • AIR TOOLS • OIL AND GAS ENGINES

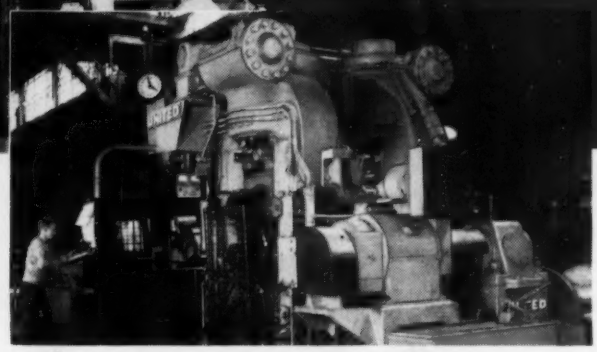
12-481

A Modern 14,500 Hp. Blast Furnace Blower

# UNITED

## UNITEMPER MILL*

**Delivery Side of United Unitemper Mill**



**Entry Side of United Unitemper Mill**

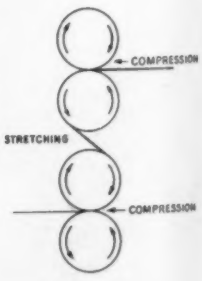
This mill resembles somewhat in appearance a conventional 4-high mill. It employs in a single housing two pairs of processing roller and tensioning units disposed vertically with respect to one another and between which the strip is processed by stretching, the strip passing in a circuitous path around these units. This stretching is accomplished by regulation of the differential in speed between the upper and lower roller tension units. In the mill the strip is reduced continuously in a sequence of operations consisting of rolling, stretching, and again rolling, the major portion of the reduction being accomplished by stretching and the processing being varied as required to secure different degrees of hardness.

UNITED UNITEMPER MILL utilizes the principle of **work-hardening or tempering by continuous stretching.** The resultant product, uniformly cold-worked throughout its entire thickness, conclusively shows superior cold-forming properties and meets as well, all accepted physical standards.

**All commercial degrees of hardness can be made with one pass through the UNITEMPER MILL, using one grade of rimming steel.** Standardization of ingot analysis, with its attendant economies, is therefore possible.

The UNITEMPER process, which embodies all of the essentials of continuous stretcher leveling, produces an **extremely flat product.**

Very low rolling pressures, as compared with conventional 4-High Temper Mills, permit use of UNITED Alloy Iron Rolls instead of more expensive forged steel rolls. This, plus savings resulting from **standardization of ingot analysis,** and savings due to a **simpler installation,** make the UNITEMPER process extremely attractive from a manufacturing standpoint.




To manufacturers of tinplate, autobody sheets, furniture stock, stainless steel panels and other specialties, in anticipation of demands for hard-rolled steel with better cold-forming properties for many fabrications, the revolutionary advantages of UNITEMPER will be apparent.

UNITED engineers will gladly furnish complete information including data based on mill production records.

**Process and apparatus patents pending.*

**UNITED ENGINEERING AND FOUNDRY COMPANY**

PITTSBURGH, PENNSYLVANIA

PLANTS AT PITTSBURGH · SHARPSCRIFT · NEW CASTLE · YOUNGSTOWN · CANTON

SUBSIDIARY: AKRON UNITED COMPANY, AKRON, OHIO

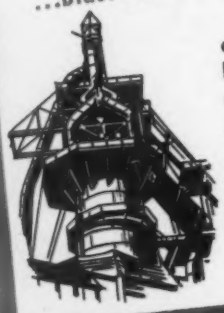
AFFILIATES: DAVY AND UNITED ENGINEERING COMPANY, LTD., SHEFFIELD, ENGLAND

**The World's Largest Designers and Makers of Rolls and Rolling Mill Equipment*

# AMPLIDYNE MAGIC

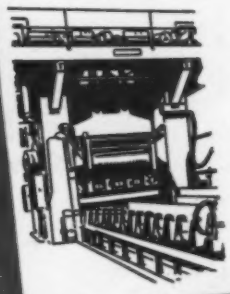
***Check these performance stories for ideas that you can use to cut costs and save time!***

**...Blast furnace produces 43,500 tons a month**



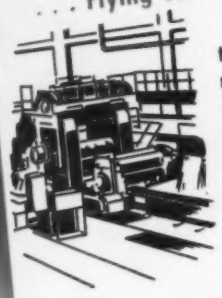
When G-E amplidynes were applied to the skip hoist of this blast furnace, they helped set a new pig-iron production record. Amplidynes speed up skip operation and make possible the flexibility of control necessary to keep hoist operation precisely synchronized with furnace needs.

**...Plate-mill screwdown accurate to .002 inch**



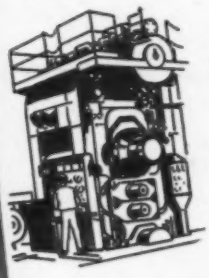
With the help of the amplidyne, 13 passes can be automatically preset on each of the two program panels of this modern plate mill. Operators avoid the time loss and strain of making manual "inching" movements, and get results accurate to better than .002 inch (up to 12-inch roll opening).

**... Flying shear costs $30,000 less**



Used as an "electric coupling" to match the speeds of the d-c motors on this flying shear, the amplidyne assures extreme accuracy of cut, at strip speeds of 2000 fpm. And—the complete control system cost $30,000 less than a conventional system.

**... Mill rolls cold strip at 3850 fpm**



Fifty per cent faster than any other cold-strip mill in the world, this mill owes much of its speed to a revolutionary new system of control. "Master mind" of this control system is the G-E amplidyne.

**...Induction furnace power restored in 2½ seconds**

Used as exciters on high-frequency generators, amplidynes hold power input to the furnace practically constant, assuring maximum melting rates continuously. On one 1250-kw generator, an amplidyne "forces" power input from zero back up to full value in 2½ seconds!

The G-E amplidyne is instantly responsive and remarkably versatile. Our booklet tells how it works, how it can magnify a 1-watt signal from a relay, electronic tube, resistor, selsyn, limit switch, or almost any source of control current, into a 10,000-watt output capable of "bossing" the biggest machines. You'll find many thought-provoking suggestions on how you can put the amplidyne to work. Ask the nearest G-E office for your copy of GEA-4053. *General Electric Company, Schenectady 5, N. Y.*

**GENERAL ELECTRIC**

760-263-1722

**AMPLIDYNES FOR STEEL MILLS**

Buy all the BONDS you can—*and keep all you buy*

# *Continuous* ANNEALING

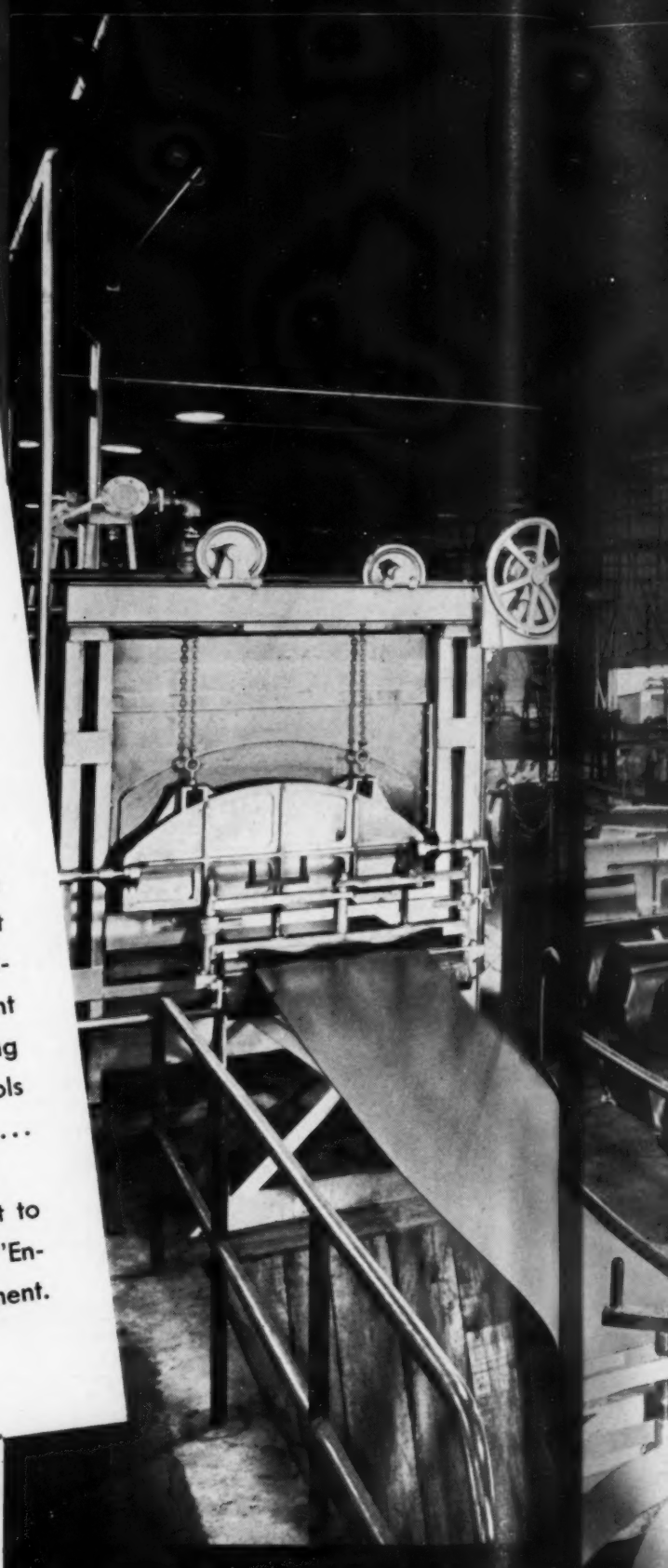
**"Surface" Roller Hearth Furnaces utilize Radiant Tube Heating and Controlled Atmospheres to provide a bright metal surface.**

For many years "Surface" Radiant Tube Heating and "Surface" Prepared Gas Atmospheres have been the choice of the steel industry for the heat treatment of strip, sheet, rod and wire.

In the accompanying illustration the continuous-type Strip Annealing and Normalizing furnaces were designed for quality and quantity production. The complete heat treating cycle . . . heating, cooling and quenching takes place within each furnace, in successive steps, providing for close operating control.

Whatever the production requirement—continuous or batch operation, "Surface" has many modern developments including the Radiant Tube and a broad background of research in the Science of Gas Chemistry and Heat Treating, to apply to the engineering of advanced heating and heat treating equipment for the specific job. With improved handling mechanisms, all these combined scientific tools have resulted in closer metallurgical control . . . greater capacities, and increased tonnage.

Wherever heat is used—from the ingot to finished product, it pays to consult "Surface" Engineers about modern methods and equipment.



## 'Surface'

**SURFACE COMBUSTION**
**TOLEDO 1, OHIO**

# G and NORMALIZING of STRIP

# CONTINENTAL
# STEEL CASTINGS

**330 Cubic Ft. SLAG POTS**

This type of casting used in the steel industry must measure up to the highest standards of quality for dependable service under varied conditions.

Continental carbon and alloy steel castings have earned the reputation throughout the steel producing industry for their dependability to withstand punishing service.

Continental also manufactures rolls, steel mill equipment and special machinery.

**CONTINENTAL** *FOUNDRY & MACHINE COMPANY*

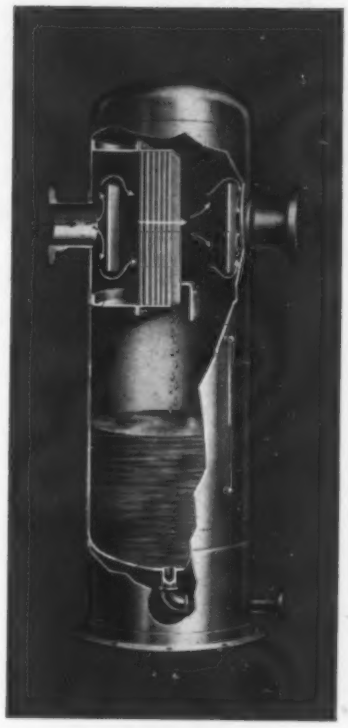
**CHICAGO • PITTSBURGH**

# A SQUEEZE PLAY REDUCES COST 20%

Squeezing the cost of a product and increasing its quality and efficiency at the same time calls for quick headwork in the engineering department and fast action on the production lines. Proof that the combination works is the new FLUOR Gas Cleaner Element.

Through the use of new materials and production techniques the heart of the FLUOR Gas Cleaner—its separator element—is now extruded to provide 40% more surface for impingement of liquid particles than its highly efficient predecessor. Liquid carry-over in the older unit was too negligible to measure; and the newer separator is more efficient.

And now the new FLUOR Gas Cleaner, with its higher efficiency, actually costs 20% less. That means you get maximum performance at the same price you now pay for equipment of much lower efficiency.



*Write for illustrated bulletin.*

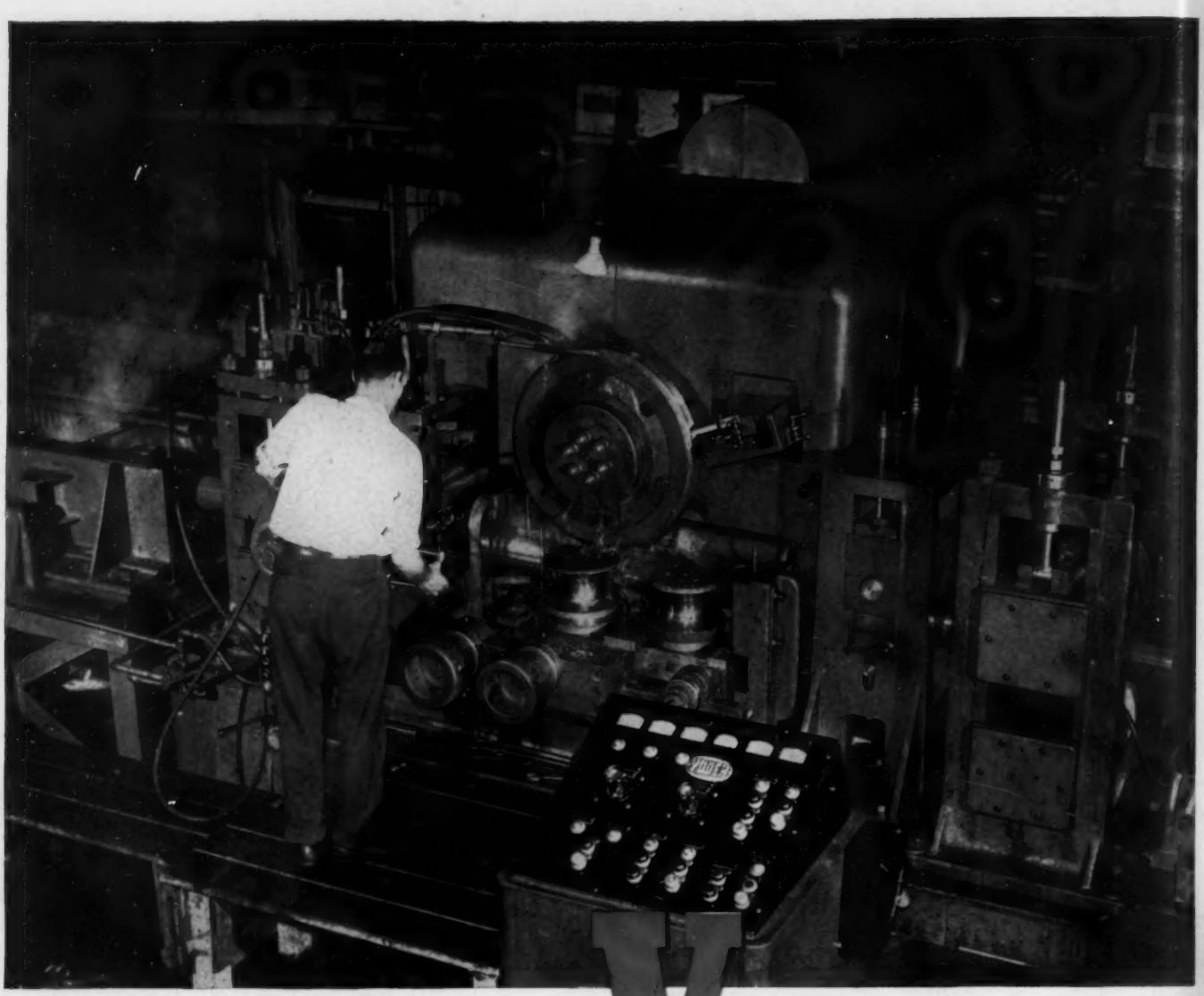
SINCE 1890 · BE SURE · WITH FLUOR

# FLUOR

**ENGINEERS • MANUFACTURERS • CONSTRUCTORS**

PROCESS PLANTS AND EQUIPMENT FOR THE OIL, GAS AND ALLIED INDUSTRIES

THE FLUOR CORPORATION, LTD., 2500 S. Atlantic Blvd., LOS ANGELES 22 • New York, Pittsburgh, Kansas City, Houston, Tulsa, Boston



*Making invasion pipe on Yoder Tube Mills equipped with Timken Bearings.*

# *Arteries of* Victory

Now it can be told that one of the most potent of our "secret weapons" in downing the Nazis was the invasion pipe line.

Following the invasion forces across the English Channel; across France, Belgium and Holland; across the Rhine and into Germany itself; these pipe lines were truly "Arteries of Victory"—for they conveyed the fluids that represent the life-blood of modern mechanized armies—gas and oil.

American productive genius, represented in this instance by the Yoder Company, Cleveland, Ohio, designed and built the mills upon which the invasion pipe is made, and turned out 1200 miles of invasion pipe in its own plant. The pipe is produced by forming and welding steel strip in a continuous operation.

The Yoder Company has designed and manufactured continuous tube mills for many years and has used Timken Tapered Roller Bearings in them consistently to prevent friction; promote speed; protect against radial, thrust and combined loads; preserve alignment; and increase endurance.

You need Timken Bearings in your equipment to give it modern performance. Make sure you have them—and remember every genuine Timken Bearing has the trade-mark "TIMKEN" stamped on the cup and cone. The Timken Roller Bearing Company, Canton 6, Ohio.

**TIMKEN**

TRADE-MARK REG. U. S. PAT. OFF.

**TAPERED ROLLER BEARINGS**

# WILSON Rectangular Bell Type Furnaces for Steel Coil Annealing

One installation of 42 Furnaces and 126 Bases used exclusively for annealing tin plate coils.

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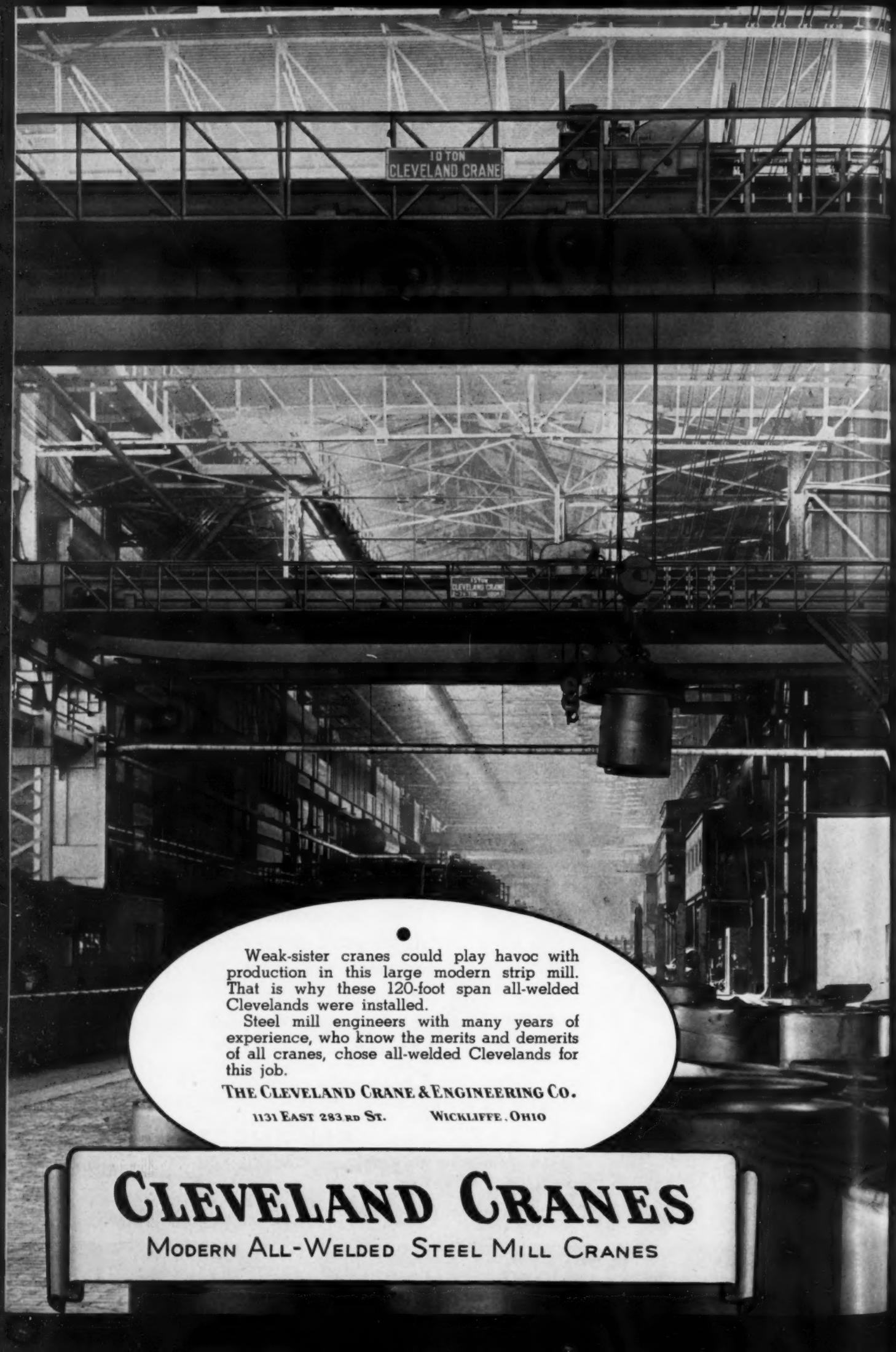


Weak-sister cranes could play havoc with production in this large modern strip mill. That is why these 120-foot span all-welded Clevelands were installed.

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# Crops *and* Shorts

ONE of our readers thinks that industry does too much engineering by precedent — that there is too great a tendency to go along in the same groove, doing things the way you've always done them or the way some other company does them. There is no denying the fact that precedent is followed to a considerable degree. Few companies can afford to invest heavily in radical changes which might result in total loss. The danger of precedent comes when it is followed blindly, with little or no thought to change or improvement — and sadly enough, we can't say that this never happens. Some people are afraid of change — like the man who had an aversion to margarine, but since he couldn't tell the difference between butter and margarine, he ate neither.

▲

A NEW record for pig iron production was set in July by No. 2 blast furnace at Edgar Thomson works of Carnegie-Illinois Steel Corporation, with a monthly production of 50,590 tons. This tops the record of 49,705 tons held since 1943 by Great Lakes Steel Corporation. In setting the new monthly figure, a daily record of 1976 tons and a weekly figure of 12,189 tons were registered. This furnace was built two years ago by Carnegie-Illinois for the Defense Plant Corporation.

▲

A CONGRESSIONAL committee has expressed concern because under terms of closed-shop agreements a veteran could be forced to join a union even against his own wishes. They report "Our veterans have earned the right to jobs without strings attached."

Far be it from us to deny the veterans this privilege but we have always felt that this right belonged to every man. Maybe we've been laboring under a delusion, but at any rate, Congress must now pass a bill to insure returning servicemen "the freedom to work for their daily bread without paying tribute." Perhaps the rest of us will have to join the Army so we can enjoy the same right.

▲

AFTER Washington has exhausted all other experiments, we hope they will try old fashioned common sense.

EXPERTS who have surveyed bomb damage state that, by and large, German plants, though knocked out of immediate production, could be placed back in operation in one or two months. Reports also indicate that Germany had large quantities of materials and much manufactured equipment on hand.

▲

PERHAPS it is our innate dislike for unnecessary work cropping out, but after reviewing endless manuscripts of technical articles, news releases, etc, we are moved to mention the lack of uniformity in abbreviations. There is a standard on "Abbreviations for Standard and Engineering Terms," ASA-Z10.1-1941, which can be obtained from the American Society of Mechanical Engineers, 29 W. 39th Street, New York, New York.

Other irregularities prevalent in manuscripts are the use of simplified spelling (which has not been widely adopted) the tendency to abuse capital letters, and overdoing the use of trade names.

▲

ACCORDING to Bureau of Mines statistics coke production in 1944 totaled 74,037,817 net tons (67,064,795 tons from by-product ovens, 6,973,022 tons from beehive ovens). The average cost of coal delivered at the ovens reached an all-time high of $4.90. About 80 per cent of the coke was used as metallurgical fuel in blast furnaces.

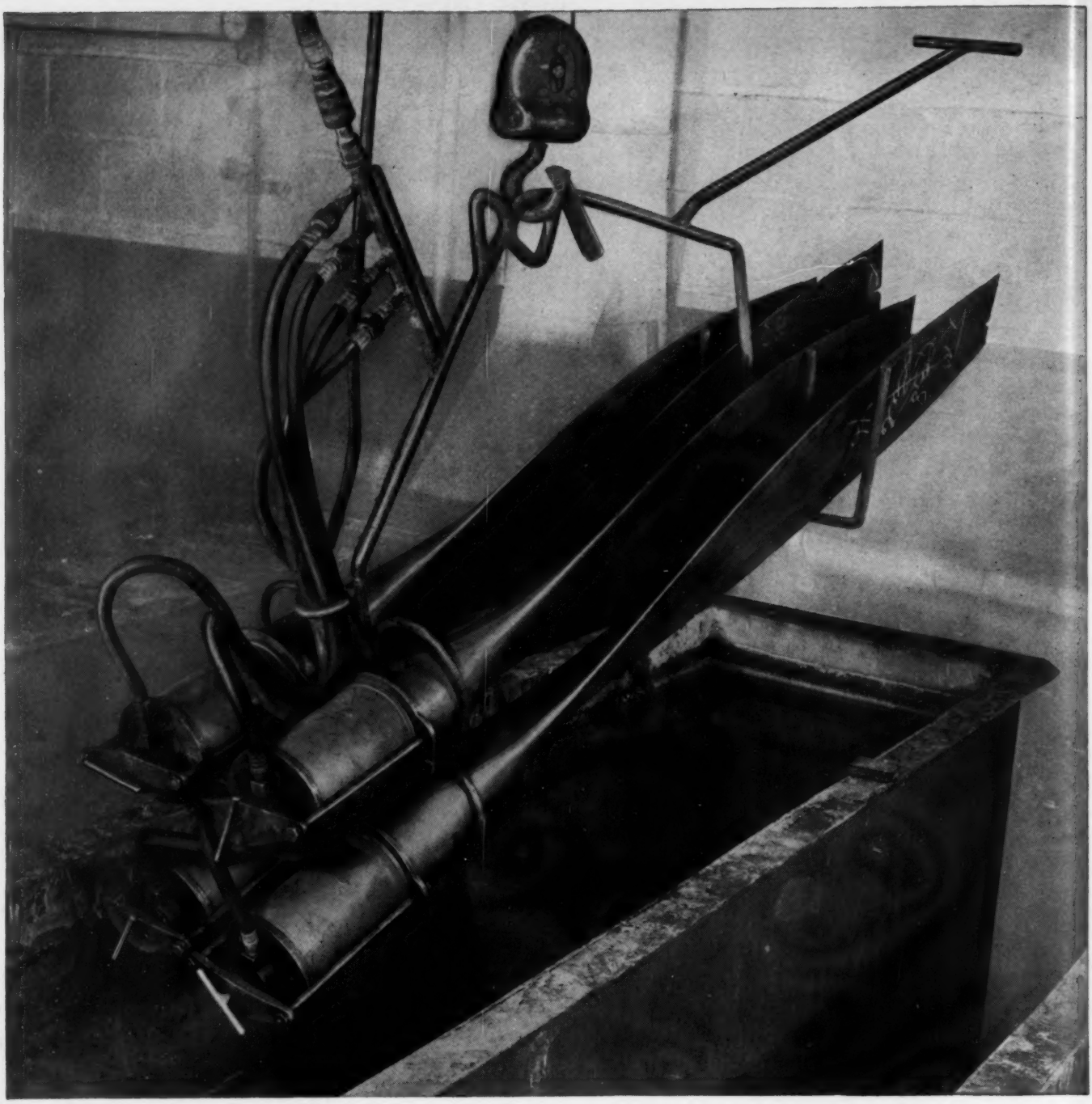
In existence at the end of 1944 were 14,580 by-product ovens with an annual capacity of 72,330,200 tons of coke and 16,318 beehive ovens with a capacity of 10,438,386 tons per year.

▲

IN a message to employes of the Link-Belt Company, president William C. Carter says, "Remember, always, that it is the buyer of our products — the customer — and he alone, who makes our jobs and keeps them going; but he isn't 'crazy in the head' and he won't pay us more for what he wants, if he can get the same value for less money from our competitor." That's a thought worth remembering and one which many individuals and companies will have to relearn.

▲

THIS stands for honorable service to our country.



# Where corrosion "gets the air"

PICKLING ACID in the root cavities of steel propeller blades can't be completely neutralized or removed. Nor can it be left in the cavities, where simultaneous action of corrosion and stress will reduce the fatigue limit of the blades.

Engineers of a well-known manufacturer of propellers for Army Air Force fighter planes tried various fixtures and plugs designed to seal the blade root during the pickling operation.

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Plugs seal the blade root. Absolute exclusion of acid from the cavities is obtained by applying dried air at —50°F. to the blade root under a pressure of 5 psi. Clamps which slip over the blade cuff ring are secured by screwing the assembly head against the blade root.

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# Why "Regulex" is No. 1 Arc Furnace Control

## LOWER MELTING COSTS, REPORTED BY SCORES OF ELECTRIC FURNACE OPERATORS WHO USE RUGGED REGULEX ELECTRODE CONTROL, HELP EXPLAIN ITS RAPID RISE TO TOP POPULARITY

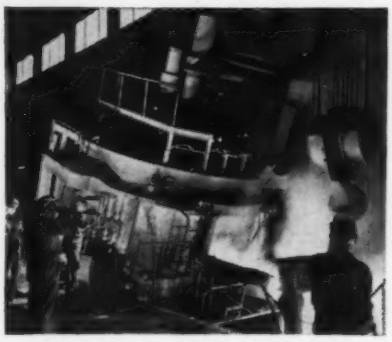
TODAY, Regulex control is acclaimed as *the most popular of any modern arc furnace control.* By its low maintenance and superior performance, it has outmoded conventional, slow-acting controls of the contactor type.

The Regulex control consists of a very simple, continuously-connected system of generators and motors.

Regulex generators, one for each electrode motor, are driven on a common shaft from a standard induction motor.

### Balanced Control Circuit

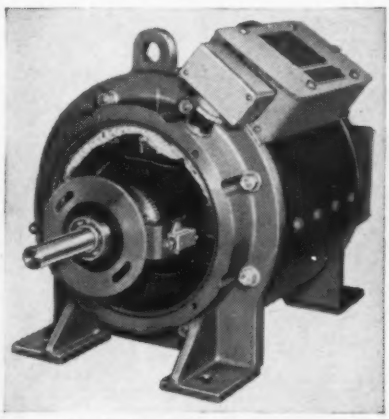
The Regulex system is able to adjust itself to any demand, no matter how small or how large — an important characteristic in an arc furnace control.



Furnace Using Regulex Control

When the balance of voltage and current in the furnace arcs is upset, the control fields of the Regulex generators become correspondingly unbalanced. Instantly, the control supplies an amplified voltage to the electrode motors, causing them to raise or lower the electrodes, correcting the power unbalance.

*Continuous, smooth, and stepless regulation results. No mechanical brakes are needed.*



Sturdy Regulex Generator

By accurately controlling electrode position during all the changing conditions of the furnace charge, Regulex control lowers kilowatthour cost per ton of steel, because wasteful current peaks are ironed out. Melt-down time is shortened . . . furnace production is boosted!

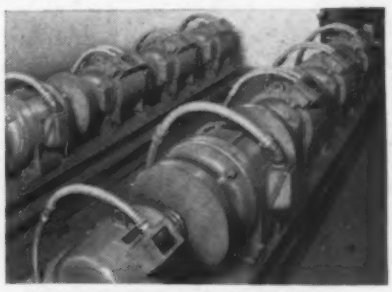
### Standard Machine

The Regulex generator is a sturdy, standard commutator machine, *which requires no tricky brush adjustments.*

Springs, levers, contactors, etc., are replaced in the control scheme by the Regulex generator, which has *only its armature* as a moving part. Maintenance is slashed!

### Unique Advantages

*As an exclusive feature, Regulex control can be equipped with flywheels, which automatically raise*



Regulex Control Flywheel Sets

*the electrodes when power fails. The auxiliary generator can make the entire control independent of a d-c shop source when desired.*

### Pays for Itself

Varied field experience has proved that in time and power savings, *not counting maintenance economy,* Regulex control often pays for itself within a few months. Kilowatthour consumption on furnaces equipped with Regulex control *may be cut as much as 10%,* in comparison with power costs on furnaces equipped with older-type controls.

### Ask Furnace Manufacturer

Your arc furnace manufacturer will be glad to tell you about Regulex control for new or existing furnaces. Or write directly to ALLIS-CHALMERS, MILWAUKEE 1, WIS.

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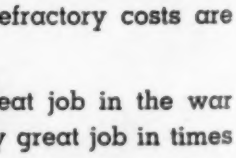


**PITTSBURGH LECTROMELT FURNACE CORPORATION**

**PITTSBURGH..30..PENNA.**

# THE *Outlook* FOR *Electrolytic Tin Plate*

***. . . . at present, wide variation in the corrosion resistance of electrolytic tin plate precludes its use for processed cans without enameling . . . . the future of the electrolytic plate in this field depends on consistent production of a highly resistant plate . . . .***

*by K. W. Brighton*

RESEARCH DEPARTMENT
AMERICAN CAN COMPANY
MAYWOOD, ILLINOIS

▲ DURING the war the use of electrolytic plate has been the principal means by which the available supply of tin was stretched so that canned foods might be available to the civilian population as well as to our armed services and our allies. As the end of the war approaches there is increasing interest in what the outlook for electrolytic plate in the postwar period will be.

It is our opinion that the outlook for electrolytic plate is quite promising. Large quantities of electrolytic plate will probably always be used for non-processed cans, and if the generally rising level of corrosion resistance can be increased to equal that of the best samples that have been produced, the plain plate may become satisfactory for many processed food cans.

The use of electrolytic plate during the war can be considered highly successful and a real tribute to those in the tin plate and can manufacturing industries who spent night and day getting their lines into operation. The necessity for rapidly expanding the production and use of the electrolytic plate without the usual developmental work created many temporary problems for the mills and for the can manufacturers. Most of the problems have now been overcome and each year a greater quantity of electrolytic plate has been produced. The total consumption was about 13,500,000 base boxes in 1944 and it is estimated that the consumption in 1945 will be about 50 per cent greater.

The present uses for electrolytic plate specified by the War Production Board in Order M81 amended January 1, 1945, are shown in Table I.

At the present time most of the electrolytic plate is used in cans for processed food products, but it is probable that when the steel and manpower to make non-processed cans are available, tin will still be scarce and so electrolytic plate will be specified for these cans.

The industrial cans, or non-processed cans as they are known in the industry, are used for packing of such products as coffee, motor oil, beer, shortening, lard, tobacco, paints, etc. A photograph of representative non-processed cans is shown in Figure 1.

The non-processed products consist of a few large volume items and a great many smaller ones. The six largest items constitute 60 per cent of the total business, while the 77 remaining classes represent less than 40 per cent of the total business. These large items have been periodically added to the list of products packed in cans and each in its turn has contributed that additional volume which is necessary to promote healthy growth in an industry, the last commodity to show rapid expansion being beer.

Presented before A. I. S. E. Pittsburgh District Section Meeting, March 12, 1945.

**TABLE I**

**ELECTROLYTIC PLATES SPECIFIED BY ORDER M81**

**(January 1, 1945)**

**PRINCIPAL FOOD PRODUCTS**

| Body | End | Tin, lb per 1000 No. 2 cans | Products |
|---|---|---|---|
| 1.50 hot dipped | .50 | 2.88 | Apple products, figs, fruit cocktail, mixed fruit, peaches, pears. |
| 1.25 hot dipped | .50 | 2.50 | Beans (green), mixed vegetables with tomatoes, mushrooms, okra, pimentoes, pumpkin and squash, salmon, soups, spinach, sweet potatoes, tomato juice. |
| .75 | .75 | 1.90 | Sweetened condensed milk. |
| .50 | .50 | 1.27 | Beer (Army), butter, chocolate syrup, corn, dehydrated foods, dry milk, fish products, frozen foods, peas. |
| .50 | CTS | .83 | Beans (shelled), beans with pork, meats, succotash. |

Due to the shortage of tin, steel, and manpower during the war, the production of non-processed cans has been drastically curtailed. We, therefore, do not have much commercial experience with the modern electrolytic plate in non-processed cans. Before the war most of the 0.5 lb electrolytic plate then available was used for coffee cans or cans for other dry products. The principal requirement of these cans was rust resistance, and under the favorable storage conditions that such cans enjoy, the electrolytic plate performed very satisfactorily. This electrolytic plate was principally the scratch-brushed product. Since that time melting of the tin, and other changes have improved the rust resistance as well as the appearance, solderability, aging, and other characteristics of the plate.

The general improvements in the electrolytic plate have led to the hope that it will be possible to obtain satisfactory performance from the present plate bearing a .25 lb coating of tin. However, because of restrictions, it has not been possible to make the extensive shipments of .25 lb electrolytic plate cans which will be required before we know whether the plate has enough rust resistance to provide protection in transit to the packer's plant, in storage at the plant, and after packing in normal distribution channels, and finally in the hands of the ultimate consumer. Fortunately, most of the non-processed cans differ from the processed food cans in that they are lithographed on the outside, so the atmospheric rusting hazard is confined to the inside of the cans.

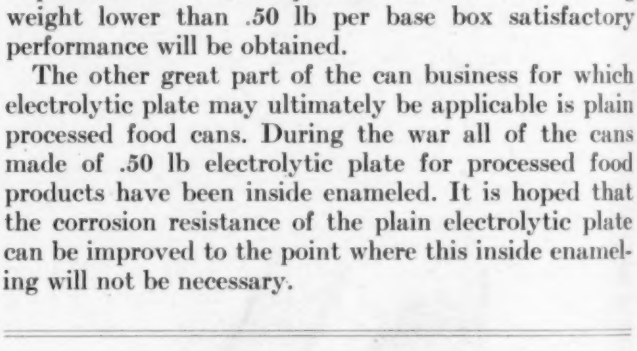
Due to the restrictions there is also a lack of information on the internal corrosion that may be encountered through action of the product. However, experimental packs of various types of products have been made and the results will in time be available. From the experience obtained with pre-war electrolytic plate, it is hoped that .25 lb electrolytic plate will be satisfactory for such large volume items as coffee, motor oil, shortening, lard, oil paints, etc. It is important that satisfactory performance be obtained from .25 lb electrolytic plate for these products if possible. In the years immediately following the war tin will remain scarce and .25 lb electrolytic plate is probably the lightest coating weight that can consistently be soldered satisfactorily. If steel and manpower become available while tin is still scarce, the War Production Board or other government authority will probably specify enameled bonderized or black iron ends on soldered .25 lb electrolytic bodies for non-processed cans wherever possible.

This attitude has already been shown in the January 1, 1945, amendment to Order M81, where .25 lb electrolytic plate is allowed for the soldered parts of cans for certain non-listed, non-food products. However, the joker in this matter is that can manufacturers do not have the labor to make these non-listed cans for civilian use. It is also interesting to note that during the current shortage of lead and the shortage of labor in the mills, can manufacturers are urged to use .25 lb electrolytic plate for certain soldered parts in place of specially coated manufacturers' terne plate.

There was no particular reason for the selection of a .25 lb electrolytic tin coating; it, like the .50 lb coating, was chosen entirely arbitrarily. It may be that this coating of tin will not provide adequate service in non-processed cans and that a higher coating weight will be required. However, we predict that at some coating weight lower than .50 lb per base box satisfactory performance will be obtained.

The other great part of the can business for which electrolytic plate may ultimately be applicable is plain processed food cans. During the war all of the cans made of .50 lb electrolytic plate for processed food products have been inside enameled. It is hoped that the corrosion resistance of the plain electrolytic plate can be improved to the point where this inside enameling will not be necessary.

**Figure 1 — Representative non-processed cans which offer a large potential market for electrolytic plate when the application is permitted.**



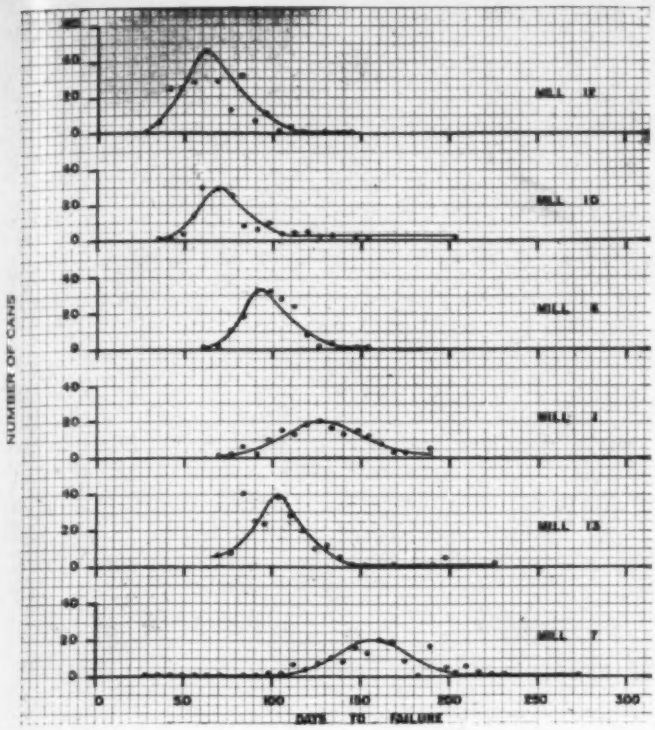



**Figure 2 — Summary of corrosion resistance results. Dried prunes in water, No. 2 cans, .5 lb electrolytic plate.**

During the last several years a large number of packs of various food products have been made in cans fabricated from plain .50 lb electrolytic plate to determine the corrosion resistance of the plate. The results of the first packs indicated that only short shelf lives would be obtained. However, since that time some examples of excellent shelf life have been obtained along with the other results. The principal problem now facing the tin mills is, therefore, to learn why certain of these samples give excellent performance, and then to raise the general level of corrosion resistance to equal that of the better samples.

The problem of improving the corrosion resistance of the plate is a most difficult one. Before a scientific attack can be made, variable by variable, it is necessary to improve the uniformity of the plate now being made on the lines so that the spread in corrosion resistance can be reduced. At present the performance of samples selected from any lot of plate is not particularly significant because these samples may be either better or poorer than other samples made the same day, on the same line, under essentially the same conditions.

Examples of the spread in corrosion resistance that have been obtained are shown in the Figure 2. In this particular experiment, six different mills were asked to supply 10 sheet samples from the head, center, and tail of each of five different coils. The steel was all of the same heat and each coil was annealed in a different annealing box. The coils were tinned at two hour intervals, and the orientation of each of the sheets was marked so that it was known which were the top and bottom sides of the sheets and which were the lead edges.

Upon receipt at the laboratory, plain No. 2 cans were made from the left edge, left center, right center, and right edge areas of the top sides of certain sheets and an equal number from the corresponding areas on the under sides of other sheets. The cans were packed with dried prunes in water and stored at 100 F. Dried prunes were used because they are available all year and because comparative results can be obtained with prunes more rapidly than with other food products. Each week the cans were examined and a record kept of the number of weeks that elapsed before each can failed due to the generation of hydrogen through corrosion processes.

The data obtained showed some very interesting differences between the heads, centers, and tails of certain coils, differences in performance of top and bottom sides of the sheets, and differences between edge and center areas on the same sheet. However, for simplicity, the data are all shown in one frequency distribution curve in which the days to failure is plotted against the number of cans. Figure 2 illustrates the wide spread in corrosion resistance obtained in the .50 lb electrolytic plate from the six mills, and shows why the can manufacturer cannot yet use plain electrolytic plate. The best of the samples would be satisfactory in the plain state for many processed food products, while the poorest samples from any one of the mills would have given early failures with most food products.

In the hope of reducing the spread in corrosion resistance, coating weights of tin heavier than .50 lb have been suggested. The sponsors of .75 lb plate for evaporated milk have pointed out the large savings in tin that could be accomplished if this plate could be used. Experimental packs of evaporated milk in .75 lb plate have indicated a spread in performance somewhat similar to that obtained with other products in plain cans made of .50 lb plate. However, the .75 lb plain plate is now being used for the less corrosive sweetened condensed milk, and, since March 31st, for the baby size evaporated milk cans. If the results with these cans are satisfactory, and the use of .75 lb electrolytic plate is ultimately extended to the tall size, about 7,500,000 base boxes will be utilized.

Our own experiments with electrolytic plate bearing coating weights heavier than the .50 lb per base box are less extensive than with the .50 lb plate, but these indicate that some spread in corrosion resistance still exists with plate of higher coating weights which should be reduced before large quantities can be used for processed food cans.

The key to the real future of electrolytic plate, then, lies in the hands of those who are working on this corrosion problem. It has been pointed out that large quantities of electrolytic plate will be used for non-processed cans, and if this problem of increasing the general level of corrosion resistance to equal that of the present better samples can be solved, electrolytic plate will be well on the way toward replacing hot dipped plate, and the next problem will then be the construction of more electrotinning lines.

*Note: Discussion of Dr. Brighton's paper is combined with that of Mr. Timby's which follows immediately.*

# SOME FACTORS IN THE PRODUCTION OF

# *Electrolytic Tin Plate*

***. . . . every step in the manufacture of plate and its subsequent coating influences the final product . . . . progress depends on investigation of the various phases and interchange of information . . . .***

*by T. G. Timby*

METALLURGICAL DEPARTMENT
JONES AND LAUGHLIN STEEL CORPORATION
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▲ ABOUT two and one-half years ago, the fortunes of war and national necessity compelled a drastic reduction in the consumption of tin in the manufacture of tin plate. This had to be accomplished without a corresponding reduction in the quantity of tin plate produced.

To meet the ½ pound coating weight limitation, quite a number of the steel mills of the country installed the electrolytic tin plate process, a manufacturing operation totally unfamiliar to many of them. The industry promptly discovered that it was confronted by a wholly new set of problems in addition to those already familiar in hot dipped tin plate experience.

Tin plate, unlike some other commodities, is sold on the basis of both appearance and performance, and standards for both had been established by hot dipped tin plate. When electrolytic tin plate went on the market in some quantity in 1942 the user was well aware that this newer material, because of the war limitations put on it, could not be expected to meet entirely the older standards, and yet the comparison between the two was undoubtedly always present in his mind. For this reason, as well as because of war-time necessity, it was imperative that the utmost possible in appearance and performance or service value should be provided in the newer material as quickly as possible.

Presented before A. I. S. E. Pittsburgh District Section Meeting, March 12, 1945.

This discussion is in the nature of a progress report covering some of the things that we have learned the hard way in our efforts to meet the above requirements. I think that the term "progress report" is used advisedly because, in spite of the distance that we have travelled in a relatively short time, I feel quite sure that the technical and operating staffs serving the industry have not yet "played out their string" and that further improvements will follow. Certain suggestions will be made as to lines of investigation that, it is hoped, may be helpful to these men.

In the beginning it was, of course, recognized that no change was called for in base plate requirements in the matter of steel soundness. However, it was evident that, if the plate were to carry a coating approximately 38 per cent of former thickness, the requirements as to surface finish on the strip must be radically tightened. Some surface blemishes, affecting appearance only, could no longer be covered up and must be eliminated.

The genesis of good tin plate is, of course, in the steel-making end and although this is true for all steel products it is especially so for tin plate because of the thinness of the finished material. Steel-making practice must be such that the slabs for tin plate rolling reach the hot mill free from any condition that would result in seams, blisters, surface defects or cracked edges in any of the rolling operations. The hot band must go to the pickler free from heavy oil or grease and must likewise be free from scale as it leaves it.

The strip emerging from the cold reduction mill must be within the gauge tolerances and free from roll marks or any mill-imparted blemishes. The film of rolling lubricant remaining on the strip must not be too heavy nor should it have any tendency to be gummy; the lubricant, as applied to the mill and strip, should be clean.

It has been claimed, although the evidence was not conclusive, that a dirty cold reduction lubricant promotes the embedding of foreign matter in the steel and that this foreign matter is apt to escape removal during subsequent cleaning. This is detrimental to the continuity of the tin coating. In any case, it scarcely seems worthwhile to take a chance and it is certain that attention to these items permits more efficient cleaning. This step, which follows cold reduction, must leave the strip chemically clean. If electric current is used, it is not uncommon to make the strip alternately anodic and cathodic. Quite a range of industrial cleaning agents is available and among these, various silicate compounds have been very popular. P. D. Liddiard (Metal Industry, Vol. 65, page 210) reports an investigation on the effect of the more siliceous silicates in electrolytic cleaning. Hall and Hogaboom's abstract of the above (Metal Finishing, January, 1945) states that Liddiard found anodic polarization which he believed due to a buildup of silica ions around the anode, since the film could be wiped off. Liddiard recommended that such cleaners should be used without current. On reading the above abstract it came to mind that at one time, in connection with experimental plating work, we did some electrolytic cleaning with a silicate material. We encountered the deposition of a gelatinous substance on the work that had the appearance of silica. If the above is at all indicative, it may be that under favoring conditions some of the silicates may be responsible for obscure cleaning troubles that at times arise. It appears worthwhile to investigate this and to determine carefully the proper operating conditions for the use of such cleaners.

I repeat that the strip should be chemically clean when it goes into the annealing furnace. This latter operation must be so conducted that the strip comes out bright and free from discoloration. The as-annealed hardness must be such as will permit the temper mills to impart flatness and good surface finish, and at the same time the requisite temper for the intended use. Again, there should be no roll marks or mill-imparted blemishes.

In the matter of surface smoothness, a considerable difference of opinion exists. Some tin plate users prefer a finish that shows a good deal of residual stone mark or shot pattern; others want practically no pattern at all. It is to be regretted that we have, as yet, no convenient and exact method of defining relative surface smoothness. Such a method should permit the use of numerical values; possibly some modification of a reflectivity method would show promise. This is another field that should be investigated.

As an aid to final inspection it is good practice to edge-trim coils to the specified width as the last operation before putting the coils on the plating line.

My mention of the various steps in strip preparation has necessarily been rather brief. It has been my intent to stress results rather than methods, because practices differ in achieving the same ends. Because this mention has been brief, do not assume that any of the above preparatory operations can be slighted if it is the intent to make a quality product. This holds true regardless of the type of plating process that is to follow.

We now come to the electro-plating line. It has been generally assumed that, if the previous preparation of the strip has been good and it arrives at the line in an apparently clean condition, it should be ready for pickling and plating. There has developed, however, a considerable body of opinion that the above preparation is not sufficient in the matter of surface cleanliness if the utmost in service value is to be obtained from the present day light tin coatings.

It has long been an axiom of the plating industry that good coatings cannot be obtained unless both the work to be plated and the plating solution are clean. Some of us in the industry feel that it is not merely the visible dirt or soil that we should be concerned about and that there is justification for giving the strip another alkaline electrolytic cleaning immediately prior to pickling; we feel that this matter of strip cleanliness cannot be over emphasized.

There is probably considerable latitude of choice as to the alkaline agent or combination used; however, as previously indicated, cleaners of the silicate type, as now supplied, should be further investigated to determine whether special precautions are necessary to prevent these very worthy materials from getting us into trouble.

Alkaline electrolytic cleaning, by its very nature and action, will remove surface contamination that pickling in line cannot be expected to touch; this applies especially to accidental smears or films of oil and grease; once these are removed, a uniform pickle should be obtained. Thus far it appears that the usual sulphuric acid solution is adequate to remove the very thin film of oxide that is always to be found on the surface of the strip. Pickling should of course be followed by a thorough scrubbing combined with a cold water rinse, possibly with two scrubbers, one hot and one cold.

This brings us to the actual plating operation. Comments and observations thus far made apply to the preparation for plating in any type of solution now in use. Since the author is more familiar with the alkaline bath, most of the following will be chiefly applicable to that type. Since it differs radically in chemical character and behavior from the acid bath, its equipment, operating conditions and many of its problems are also different.

The equipment in general use for alkaline plating is known as the Crown line. Usually there are some modifications in design or arrangement to accommodate it to individual mill conditions. Two entry pay-off reels are provided and used alternately to permit continuous operation; next comes the electric welder which joins the preceding strip to the one following. Since no one has yet provided us with practical equipment for welding on the run, an uninterrupted flow of strip to the line is maintained by feeding in the required amount from the entry looper tower. Next follows the pickling, scrubbing and washing operation; in the plating tank the strip passes up and down between 48 suspended tin anodes. These anodes are 3 in. thick and 30 in. wide, with an immersed area up to approximately 2100 sq ft. The plated strip passes out of the plating tank through

rinsing sprays and squeegee rolls into the first plating rinse tank where the washing is completed with high pressure sprays. Next comes the second plating rinse tank where the strip is dip-washed in condensate slightly acidulated with hydrochloric acid. It is then passed through wringer rolls and the hot air drier, and is then ready for brightening. We use induction heating to melt the dull, as-plated coating to convert it into the customary bright finish, and complete the operation by a water quench.

The brightened strip now passes in order through a weak chromic acid solution, a final water rinse, wringing rolls and the exit drier; next comes the exit looper tower and vapor oiler, followed by recoiling on the take-up reel.

The current available for plating is nominally 72,000 to 75,000 amperes; the solution used is potassium stannate plus potassium hydroxide, and is continuously filtered during operation, since we believe that the solution as well as the strip should be kept clean.

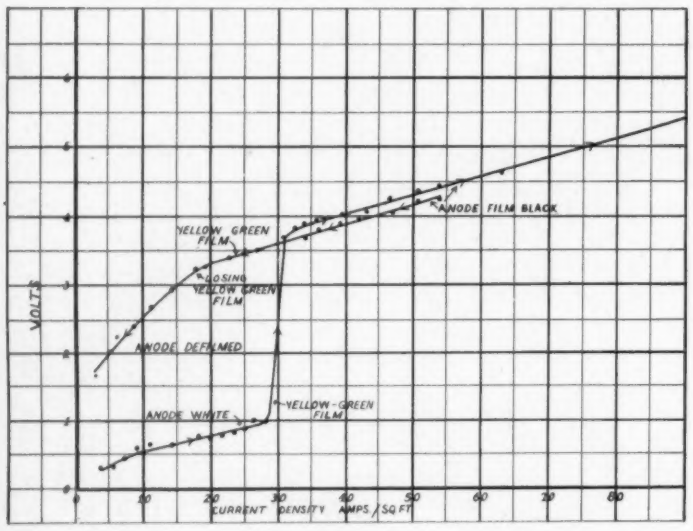
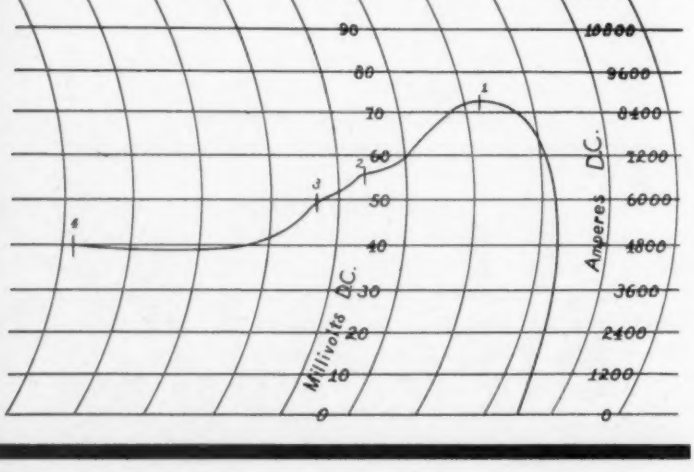



**Figure 1 — Filming and defilming curves. Potassium stannate bath, 70 C; tin content, 37.89 gr per liter; free caustic 15.42 gr per liter.**

▲

**Figure 2 — Chart from one generator during filming and subsequent adjusting to reach desired operating value.**




The operation of starting the line is comparatively simple. The line having been previously threaded, the first coil to be plated is welded to the end of the threader strip, and puller and pinch rolls are started. When the production coil reaches the proper point in the line, current is applied to the anodes to film them. A very heavy current is used for a short time and this results in the formation on the anode surface of a yellow-green film which consists of a mixture of hydrated stannous and stannic oxides. As long as this film is maintained, the tin of the anodes passes into solution in the stannic form. The film being established, the current is reduced to the desired operating level and plating procedes. If the filming current input is continued too long, the yellow-green anode film will change to brown and finally to black, and the anode becomes inactive. The electrical characteristics of the filming operation are rather interesting and some voltage-current graphs are shown herewith.

As I have indicated, the tin plate industry found that the electrolytic process provided a good many troubles and worries, especially in the earlier stages. Foggy plate was a condition, I believe, that at one time or another plagued all producers. Some encountered soldering troubles and discoloration during storage. Uneven enamel adhesion was another worry. The industry, in general, has taken care of these various troubles.

Foggy plate in our case, we believe, was due to several causes; at first, I think we lacked an appreciation of the necessity of keeping all rolls clean. The type of roll covering then used may have had some bearing on the matter. Another cause, we think, was a somewhat elaborate drag-out recovery system. However, the use of condensate together with better preparation of the strip and process care eliminated the trouble.

We thought at one time that it might be advantageous to increase our anode area somewhat beyond that obtainable with a flat slab. In the course of investigating this we prepared an experimental corrugated anode. We decided first of all to find out something about the current distribution on such a contour; the figures we obtained surprised us. This led us to check the distribution on both a plain flat anode and on a flat that was keystone shaped. The results are quite interesting.

It may be recalled that I mentioned the voltage-current relationship during filming. Figure 1 shows the relationship that we found experimentally by steadily increasing the current input from zero to about 70 amp per sq ft. The sharp rise in voltage occurs at the instant of film formation. This is known as the Hyman-Lucasse curve.

A truer picture of what happens can be obtained as follows: Cut off the current and allow the anode to defilm; raise the current rather quickly to a value just short of the point where the voltage rise started and wait for filming to occur. In this case the voltage will rise as before but the amperage will drop off and the shape of the curve will be that of a reversed "Z" if you again increase the current after filming.

Figure 2 is a graph taken on one of the line generators during filming; the chart speed was ¼ in. per second. In this case the maximum voltage and current were applied all at once; at point 1 filming began and the amperage started to drop and it began to level off just ahead of point 2, showing that filming was complete;

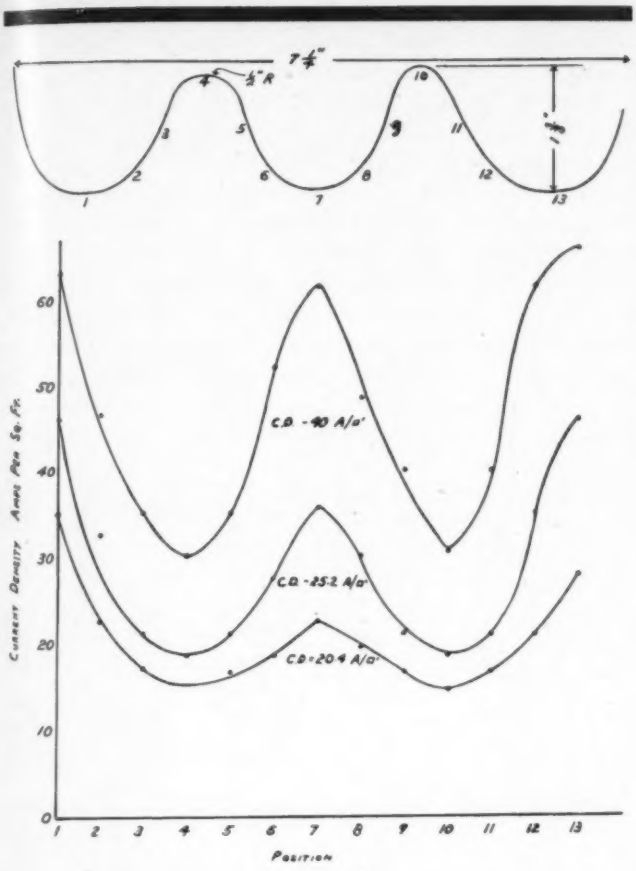



**Figure 3 — Horizontal current distribution at one level of immersion on corrugated anode.**

the operator then made adjustments and at point 4 had reached the desired operating value.

Figure 3 shows the horizontal current distribution at one level of immersion on the corrugated anode that was mentioned earlier. The actual current densities may be slightly more or less than those shown on the graph — that is, the vertical location of the curves may not be entirely right. We do feel sure, however, that the relative orders of magnitude are correct. The wide variations in current density distribution suggest that, in the overall, this anode might not be too practical.

Figure 4 shows experimental densities found on a conventional flat anode. In this case we took readings over the entire surface of one face. The edge effect is clearly discernable. However, general operating experience has shown that this type of anode is serviceable and practical. The flat anode also changes but moderately in area during its useful life.

Figure 5 is a keystone shaped anode explored in the same manner as in the preceding case. It also is a flat anode. It will be noted that the edge effect is more pronounced than was found on the conventional rectangular form. One might infer that this keystone would "black-film" very readily on the corners and edges.

It may be noted that in all of the cases shown the current density increased as you go more deeply into the solution down the face of the anode. I confess that this was rather a surprise to us. We even checked this on the plating line during operation by taking readings from the surface down to 5 ft below the solution level, and we found the same trend. This form of investigation, we decided, was rather hazardous and we did not pursue it.

I am well aware that there is nothing new or startling in all of the precautions that I have cited as prime requisites both in the production of strip for electroplating and in the electroplating operation itself. In the urge for production it is human to let some things slip and this presentation is intended as a reminder.

At the moment, continuous electroplating with tin appears to be more of an art than a science; it should be both an art and a science, and it is due to an interest in the latter that the current density distribution figures were presented. It is hoped that someone will have both the urge and the opportunity to pursue either this or some other phase equally pertinent in order that the industry as a whole may profit.

In closing, I wish to make an acknowledgement to the consumers of electrolytic tin plate. They have, in general, shown a sympathetic understanding of the fact that we, as manufacturers, have been going through a trying time with this product. We much appreciate their attitude.

**Figure 4 — Current distribution on 14 in. x 9 in. flat slab anode. Potassium stannate bath, 194 F, tin 42.5, KOH 21.**

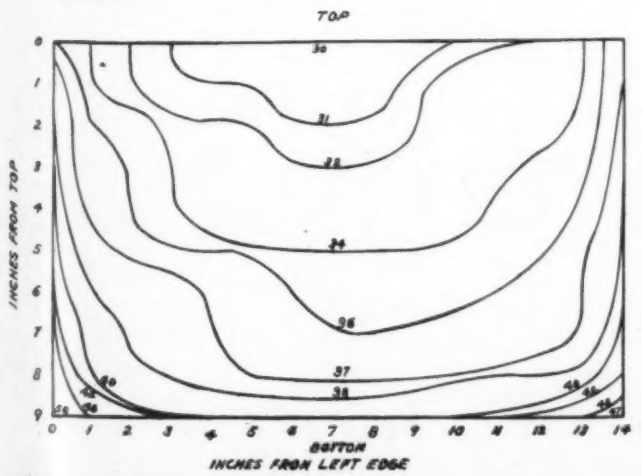
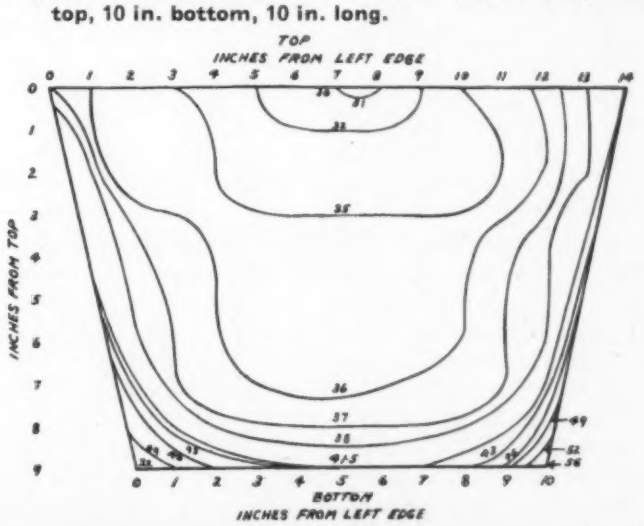



**Figure 5 — Current distribution on keystone anode, 14 in. top, 10 in. bottom, 10 in. long.**



# DISCUSSION

PRESENTED BY


BRUCE W. GONSER, Battelle Memorial Institute, Columbus, Ohio

K. W. BRIGHTON, Research Department, American Can Company, Maywood, Illinois

D. A. McARTHUR, Chief Engineer, The Wean Engineering Company, Inc., Warren, Ohio

A. L. NIELSEN, Development Engineer, Sharon Steel Corporation, Sharon, Pennsylvania

T. G. TIMBY, Metallurgical Department, Jones and Laughlin Steel Corporation, Aliquippa, Pennsylvania

H. W. NEBLETT, Engineering Department, Inland Steel Company, East Chicago, Indiana

R. B. MENEILLY, Metallurgical Engineer, Tin Plate, Carnegie-Illinois Steel Corporation, Pittsburgh, Pennsylvania

J. D. GOLD, Assistant Vice President, Quality Control Department, Weirton Steel Company, Weirton, West Virginia

C. A. KRAL, Manager, Tin Plate Division, Jones and Laughlin Steel Corporation, Aliquippa, Pennsylvania

CARL C. JONES, Special Engineer, Youngstown Sheet and Tube Company, Campbell, Ohio

E. C. MARSHALL, Chief Electrical Engineer, Youngstown Sheet and Tube Company, Youngstown, Ohio

D. A. SWALHEIM, Electroplating Division, E. I. duPont deNemours and Company, Cleveland, Ohio


**Bruce W. Gonser:** In regard to the first, there was some comment about the desirability of having cans without lacquer on the outside when using electrolytic tin plate. I wonder if Dr. Brighton would comment further on the possibility of improving the corrosion resistance without lacquering, as by a solution treatment such as that described by the Tin Research Institute. It is possible that this simple treatment is sufficient, so the expense of lacquering can be avoided and the electrolytic process helped a little further.

**K. W. Brighton:** As far as the Tin Research Institute chemical treatment is concerned, we know that it does increase the rust resistance of the plate. Whether or not it is necessary to have it, particularly when most of the cans will be used in the domestic market, is another thing. It will probably have to be decided later.

**D. A. McArthur:** We have spent a great deal of our effort outside of the chemical phase of electrotinning Obviously it was very necessary to keep the strip running through the chemical tanks continuously and at almost the same speed at all times. The entry and exit handling equipment are very important. We have noticed on one or two lines at the entry end where the new strip is joined to the succeeding strip, that the joint was going through the line in a matter of eight seconds from the time the end of the strip that was going through the line was stopped. Possibly we could cut that down to even fewer seconds. At the exit end I think the seconds have become even less but certainly we aren't at the ultimate yet.

**A. L. Nielsen:** I have been very much interested in the papers, particularly the remarks regarding the preparation of the base stock prior to electroplating. There are some phases of the art which have not been mentioned and which I believe should be brought to the attention of this meeting.

In conventional practice it is necessary to control the residual metals in the base stock in order to get satisfactory corrosion resistance quality in the finished tin plate. If the residual metals are controlled only to a value which will give satisfactory deep drawing quality, the corrosion resistance of the tin plate may be far from satisfactory, but if the base stock is given an electroplated coating of a metal such as iron or nickel-iron alloy prior to annealing, the finished tin plate will have very good corrosion resistance regardless of the residual metals in the base stock.

Tests have been made which show that ordinary low carbon steel electroplated with ½ lb of nickel-iron alloy per base box and ½ lb of tin per base box, with the tin brightened by heat treatment, is satisfactory for canning corrosive food packs. This tin plate is superior to hot dipped tin with more than twice the tin coating weight, and can be produced at a lower cost.

No matter how careful one may be in keeping the rolls of the rolling mills clean, I believe there are impurities rolled into the strip surface during skin rolling operation. We have found than an effective way to remove all the surface impurities and get an absolutely clean strip surface is to oxidize the strip surface chemically after the final skin rolling and then remove the oxide just prior to electroplating with the tin. This oxidation of the strip may be accomplished by treating the strip as the anode in a hot sodium hydroxide solution and the oxide may be removed by dipping in an acid solution. These operations can be conveniently carried out in the continuous tinning line. Tests show that when the tin plate base stock has been given a treatment to oxidize the surface and the oxide removed just prior to plating, the tin coverage is better and the tin flows more uniformly during the brightening treatment.

I would like to know what experience others have had in skin rolling of the base stock. Does the skin rolling of the base stock prior to plating affect the base adversely so as to make the plating more difficult? Or has anyone given the base stock more than the normal skin passes, for instance two passes or three passes, and noted any difference in the electroplating step due to the different number of skin rolling passes?

**T. G. Timby:** I know of no direct evidence that will answer your question. The only thing I can say is that the longer you keep the strip in process, the more chance it has of getting dirty.

**A. L. Nielsen:** When tests which show the current density to be greater at the bottom of the anode than at the bath surface were made, did the cathode extend below the bottom of the anode as it normally does in an electroplating line?

**T. G. Timby:** Yes, it did. I judge you feel that the high current density on the bottom of the anode is due to the fact that the cathode extends beyond it. Is that it?

**A. L. Nielsen:** No, I was just wondering if that was the condition during your tests.

**T. G. Timby:** As I pointed out, we pushed an exploratory electrode 5 ft down into the solution to see what we would find. There was still about 3 ft of anode and cathode below that. We found a gradually increasing current density as we went down, just as we found experimentally. We have no evidence that the bottom edge effect would be operative at the distance indicated.

**H. W. Neblett:** I think Dr. Brighton has presented a very clear picture of the problems faced by the processors of the product which we, as manufacturers of electrolytic tin plate, furnish.

I am particularly interested in what Mr. Timby has to say regarding the cleanliness of the strip. This is a point in which we are all vitally interested. I gathered that he, by stressing the cleaning and preparation of the strip through the processes prior to the actual tinning line, considers this most important. I think he probably bases this on the assumption that the processing through the tinning line is done under favorable conditions — that is, all material in the line with which the strip comes in contact is clean and is kept in this condition, thereby preventing the strip taking up any dirt or foreign material in the tinning line itself.

I would like to ask Mr. Timby if it is his opinion that cleanliness of the strip in the processes before it reaches the tinning line is more important than relying on pickling and scrubbing in the line to properly condition the strip for tinning. I would also like to know if he has an opinion as to the relative importance of the clean strip in the various processes prior to the tinning line. I know he wants a clean strip when it reaches the tinning line, but, at what point prior to the tinning line does he consider it most important to have the strip thoroughly cleaned?

**T. G. Timby:** That is a difficult question to answer because it is, I think, somewhat like the query as to the order of importance of the hen and the egg. If you don't start with good material, you certainly can't wind up with good material, and even if you are as careful as you can be in your plating operation, if the strip isn't clean when it comes to you, the product will not be satisfactory.

On the other hand, perhaps I didn't stress as much as I should have the matter of cleanliness in the plating solution. We feel that the plating solution should be clean and we continuously filter it during operation. At the moment, I do not feel that we know definitely of any point at which the matter of cleanliness may be safely slighted. I feel that you simply don't dare take a chance on its being dirty anywhere, and so you must have it clean in all places.

**R. B. Meneilly:** I am very much interested in this subject of cleanliness. I would like Mr. Timby to tell us what happens if the strip is not clean. I'm not asking about dirty strip, but what happens if the lubricant or coolant at the cold reduction mill is somewhat dirty; what happens if you don't clean it perfectly before annealing? Does it affect corrosion resistance? Does it affect enamel adhesion? Does it affect solderability?

We have been trying to determine some of these things, but we don't have conclusive answers. We are sticking with the principle that to plate properly, or to coat properly in making hot dipped tin plate, we should have a clean strip. We know that the general appearance is improved (and this is important) by extreme care in all operations, but are there any actual data that the degree of cleanliness affects the plate characteristics which I have mentioned?

**T. G. Timby:** As to lacquer adhesion, I don't know how much effect a dirty strip ahead of plating would have. Lacquer adhesion is, to my mind, purely a matter between the lacquer or enamel and the surface of the tin coating. I don't think it goes any deeper than that. So if your tin coating is proper on the surface, your lacquer adhesion should be all right.

I think we will all admit that we don't know exactly, given apparently clean strip, why at one time enamel adhesion was good one day and poor on the next — we aren't troubled that way now. As I indicated in my paper, I believe that we know, in our own case, what we did to cure that trouble. We cleaned house — that is to say, we saw to it that the surface of the strip coming out of the electrotinning line was really clean.

As to the effect of foreign matter on the strip, I would cite you this. I recall a certain pamphlet by the International Tin Research and Development Council in which they demonstrated to their satisfaction that if there was any material on the surface of the strip which would not alloy with tin, the largest dimension of which was over 70 per cent of the thickness of the tin coating applied, you would have a non-coated spot.

I said in my paper that I felt that it was not only visible dirt and soil that we have to worry about, but things that are invisible to ordinary inspection. That is why I feel that foreign material should be off the surface of the strip, because I think otherwise you interfere with the continuity of your coating. I don't know that that will have any effect on enamel adhesion. I doubt if it will have any effect on solderability, because that again, I think, is a matter solely between the tin surface and the solder.

**R. B. Meneilly:** Is there any evidence as to whether any particular type of cleaning compounds used in the cleaning before annealing, whether any particular type of cleaning equipment, or any particular types of coolants or lubricants used in cold reduction, have actually resulted in any difference in solderability, corrosion resistance or enamel adhesion?

We have seen poor looking electrolytic plate — plate that we couldn't ship to the customer — that has been satisfactory according to our serviceability tests. We think that it didn't look right because the strip wasn't clean. It is things like this that indicate that there are many other important factors affecting plate characteristics which should not be overlooked or neglected in our efforts to make perfectly clean strip.

**T. G. Timby:** You ask for evidence as to the effect on solderability, corrosion resistance and enamel adhesion of the following items:

1. Type of cleaning compounds used before annealing — I know of little or no direct evidence on this point. Quite a list of proprietary mixtures and commercial chemicals is available. Many of these are in regular use for strip cleaning, which suggests that if each is properly handled a rather wide choice is permissible. Liddiard's investigation on high silica silicates indicates that such compounds require special precautions.

2. Types of cleaning equipment — If the type of equipment employed is so operated as to do a good job, there is no evidence to my knowledge that the type is important.
3. Coolants and lubricants for cold reduction — The answer is again much the same. However, it has been suggested, and I believe with some reason, that the use of a dirty rolling lubricant may cause foreign matter to be inseparably embedded in the steel. According to the findings of the International Tin Research and Development Council, this should result in an increase in subsequent tin coating porosity. This, to my mind, should affect neither solderability nor enamel adhesion.

The answer as to the effect of porosity on corrosion resistance must await the development of really satisfactory tests for both. The present evidence is contradictory.

There are many questions for which we do not as yet have adequate answers. The case for absolute cleanliness of both strip and plate is perhaps not proven in all particulars. The logic of reason calls for absolute cleanliness and until we know definitely just how much laxity is permissible, it is wise to keep both material and process clean.

**R. B. Meneilly:** How much money can we afford to put into the preparation of strip for electrolytic plate over that required for hot dipped plate? Is there a possibility of disregarding, within reason, of course, what occurs before the cleaning operation prior to annealing? Can you put a cleaner on the electrolytic line that will take care of the problem? Again you say that it is best to start at the very beginning and keep things clean all around. That is sound, but it may be possible to clean strip immediately before it goes into the plating bath, which will permit just the ordinary operations prior to plating.

These are some of the questions which I think will determine, to a large extent, the future of electrolytic plate.

**T. G. Timby:** It is a large question, and I do not think that I can assess the money value of cleaning. Perhaps a cure-all process can be devised and applied just prior to plating that will permit the employment of just ordinary precautions in the earlier steps. Such a situation would, at first glance, appear to simplify the problem, but it would still be necessary to keep the so-called ordinary precautions up to the mark; otherwise, the cure-all would very shortly be overworked.

**J. D. Gold:** There is one question I would like to ask Dr. Brighton — a question on corrosion resistance. We realize the necessity for increasing the corrosion resistance of electrolytic tinplate. Hydrogen evolution tests are more or less erratic now on account of the synthetic rubber we must use. I am wondering if there isn't some quicker test, other than the hydrogen evolution. I would like to hear a little discussion on how we in the steel mills can study the corrosion resistance, so that it might be improved.

**K. W. Brighton:** Unfortunately, we don't have such a test, or progress would be a little faster than it now is. I don't have anything tangible to offer Mr. Gold. However, I can say that at one time we packed products like peas, meats, pork and beans, dog food, etc. in test cans, and they might last for about three years before failures. Now we are using prunes, and have shortened the time to six months or less. What we need is a test something like the hydrogen evolution test that will give you the story in a matter of hours. We have spent the last three years working on such a test in our laboratory, but don't yet have one. It would greatly speed up the tempo of the work to have one, and some day we will have one, but not right now.

I have been interested in these various comments about cleanliness, because we hope that out of that work will come an explanation for the spread we get in corrosion resistance. As I tried to point out, we have had samples from every mill that would be satisfactory for certain processed food products — for pork and beans, dog food, meats and peas; if we could get all of the plate equally good, we would be in good shape. That is the main problem that faces the tin mill people now who are interested in electrolytic plate. If they can by some means find the answer to that, and it may be through cleanliness, or, as Mr. Meneilly said, some special cleaner that will take care of all previous sins, we may have the answer.

**C. A. Kral:** We have received an interesting picture on the future of electrolytic tin plate by Dr. Brighton, and it surely indicates we have a lot of work to do for greater uniformity and stability. There is a saying that, "It is necessary to go far at times to learn how far one must go to find the correct answer." Apparently we have not gone far enough.

I am sorry I cannot subscribe to Mr. Meneilly's worries as to the advantages or disadvantages for cleaner surfaces, etc. Many irregularities are evident in the corrosion resistance of electrolytic tin plate, and while I feel we will look to improvement from the bath to the exit end, my opinion is that we will devote greater effort in preparing and cleaning the steel base before plating.

Therefore, we are constantly browsing around to learn of better means to prepare and clean the surface of the strip. None of us will deny the fact that many of the small plating companies who plate brass, copper, chromium, etc. may not have the cleanest work shops, but do spend a great deal of time and money in preparing the article to be plated.

**Carl C. Jones:** On this matter of cleanliness, it just occurs to me that the Aluminum Company of America, in rolling aluminum foil, find it necessary to enclose their mill in cheesecloth and then pump clean air into it to maintain internal pressure; otherwise they have pinholes in the foil. The atmospheric dust is certainly not as corrosive a dust as we have in the steel mill. Therefore, what must we be rolling into the surface of a sheet under our mill practices?

I would like to ask Dr. Brighton whether there is an established corrosion resistance for size of the tin grain. Also is there a relation between the amount of iron-tin boundary and corrosion?

**K. W. Brighton:** We don't have the answers to those questions yet. They are variables that have to be studied after we can be sure that the plate can be reproduced. In other words, if you produce a sample at nine o'clock today and then one at twelve o'clock under what you think are identical conditions, and they vary 20 per cent in corrosion resistance, and then at two o'clock you produce another sample in which you have

tried to vary the grain size of the tin and you got a further 20 per cent variation in corrosion resistance, you don't know whether it is a variation in the line practice or whether it is a variation in the size of the tin crystal.

If all the cans made out of half-pound electrolytic plate would stand in prunes for fourteen weeks without becoming springers, and then if we changed the crystal size of the product from one of your lines and the service life increased so that all cans failed at eighteen weeks, we would know that the change in the crystal size made a significant contribution. But we have to get reproductability first before we can study the variables of crystal size, iron tin alloy, etc.

**E. C. Marshall:** This matter of tin plating is one of great precision. It is quite obvious that we are not precise enough or we would be getting better results. I was in the hope that Dr. Brighton would have given us a lead as to what he thought might be the solution of some of the problems. In looking at his curves, I could not help realizing that we are talking about a very minute thing. He shows on the curves rather large variations for diagrammatic purposes, but in actuality, it is within a few millionths of an inch of actual coating.

One of the curves which showed the head end, center end and tail end, indicated that in almost every case the tail end was somewhat better. I am wondering if that could possibly be due to a difference in the speed of the strip at the tail end — that is, whether or not, after making a weld, the tail end of the strip remained in the pickle bath and plating tank somewhat longer. Could that be accountable for the difference in the resistance value of the tin plate?

Mr. Timby showed curves of current densities. I would like to ask how he determined those current densities at various points on the anode. I thought his corrugated anode curves indicated current conditions which follow the law on the variation of current according to the resistance of the circuit.

Where higher current density was found at the bottom of the anode, it may be that that is due to greater agitation caused by the revolving roll in the solution at the bottom of the tank, and with that greater agitation greater current should be obtained, especially in view of the relative resistance of the anode to the electrolyte.

**K. W. Brighton:** The fact that the steel industry has been willing to spend money to produce electrolytic plate during the war has saved the can industry, and we are very anxious to see electrolytic plate work for plain cans in the postwar period. If there were anything we knew, we certainly would give it to all producers of plate.

We subscribe to the cleanliness thesis. We think that there is still further work to be done there and, although we also realize that Mr. Meneilly may be right in saying that we have no tangible proof that cleanliness is getting us anywhere, we do want to see experiments conducted and continued along that line.

As far as the mill is concerned whose tail ends are giving better corrosion resistance, it is possible that speed of the line is a factor there.

**T. G. Timby:** Mr. Marshall asked if the difference in current density from top to bottom of the anode was due to the fact that on the line you may have more agitation at the bottom than higher up nearer the surface. I don't think that is the answer. The experimental curves were determined on comparatively small anodes in a small plating tank with substantially no agitation, or just sufficient agitation to maintain the mixing required for keeping temperature equalized. So I don't think agitation enters into that. When we went on to the line, on the one check we made down the face of the anode, we found that the current density did increase as we went deeper into the solution.

We had probably in the neighborhood of 8 ft of solution from the bottom of the anode to the surface of the bath. I went down 5 ft and I found every foot as I went down gave an increase in the current density. I don't think that agitation has a bearing on that. The general effect of agitation is something that we really have yet to determine — something we hope to get some results on, to find out just what differences will appear in the same type of setup with agitation and without.

We determined the current density by setting in the following manner. We set up a plating cell in the laboratory using a flat anode. We ran one lead of a vacuum tube voltmeter to this anode and the other lead to an exploratory electrode. Both leads were shielded. The exploratory electrode was a mere platinum point sealed in a glass tube. We placed that, for all density measurements, close to the surface of the anode. We took voltage drop readings, making allowance for the cell constant, for various applied current densities. From these readings we were able to plot a curve showing what current density should accompany a given voltage drop.

As I said, I am not prepared to say that, where the curve shows 35 amp per sq ft at a particular point, the actual value may not be 33 amp or 37 amp. I wouldn't want to guarantee the results that close, but I do feel that the relative orders of magnitude are correct.

**E. C. Marshall:** Your assumption is that the film is constant on the whole area of the anode?

**T. G. Timby:** Yes, we are assuming that.

**E. C. Marshall:** Have you assurance that it was?

**T. G. Timby:** I know that if you rupture the film with your exploratory electrode, or if you lose your film, there isn't any doubt about it, because the voltage drop may go from 2½ or 3 volts down to perhaps one volt or something of that order. If you put the electrode in the plating cell with current on prior to filming the anode you get a very low reading. Just the instant that anode films, up goes your voltage drop.

There may be some things that we can't be too sure about. I am not too sure as to actual anode density figures, but I do feel very sure that the relative magnitude of the distribution at various points is right, that it is comparable and that the wide differences in density shown do exist.

As to the effect of agitation, I see no present reason to think that it has any influence. We used practically no agitation in one case, and in the other case we had production line agitation, but we found the same current density trend in both. However, we hope that we will have more light on this a little later.

**A. L. Nielsen:** I believe that scrubbing of the strip just prior to the electroplating is one of the surest ways of getting a perfectly clean strip upon which to electroplate. We have been experimenting with brushes for

the past ten years and find them very effective. However the type of brushes and the method of brushing are very important items. We have found that the best brushing condition is to pass the strip over rolls in a slightly arcuate path and then brushing the convex arcuate surface tangentially with a stainless steel wire brush. This will produce very even cleaning and will tend to lift out the imbedded particles. If on the other hand the brushing is on the flat strip or on a convex surface where the strip wraps slightly around the brush, the brushing will be very nonuniform and in many cases the impurities were pounded into the surface rather than being removed.

We have also found than an extremely fast method of scrubbing is to lubricate the brush with an alkaline electrolyte and pass an electric current between the strip and the brush in the area being scrubbed. This generates gas at the metal surface in the area being brushed and lifts the impurities from the strip surface, making them very easy for the brush to sweep away.

**E. C. Marshall:** I would like to comment that, from our own experience, it looks as though we are attaching too much mystery to the electrical phase of this problem. In all this cleaning that we hear about — "do more cleaning, do it electrically" — I somehow doubt whether that is the answer. We ought to go back, as has been said before, to preparing better steel before it gets to the tinning tank.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**T. G. Timby:** In the matter of tin adherence, I have never seen a tin coating peeled, as for instance you can peel a galvanized coating. If the steel base is unsound, the surface may flake off, carrying the tin with it.

As I mentioned earlier, the International Tin Research and Development Council found that you couldn't cover a nonalloying particle that was more than 70 per cent of the thickness of the applied tin coating, in its largest dimension. We all want better steel-making. I am also certain that the surface cleanliness of the strip is important. Bad steel-making is going to give you one of two things, as I see it. The result will be either a physically unsound sheet or something that will have physical properties not suitable for the end use. We must have sound steel. Then we must also watch the surface because the surface is where the tin must take hold. That is why I have stressed so strongly my belief in the necessity for a clean surface.

**E. C. Marshall:** It all indicates that we must be precise, and we must be observing, and we must determine the cause. By better steel I meant proper analyses and physicals — also proper surface.

**T. G. Timby:** I am agreed with you one hundred per cent. We still have a distance to go. There are a lot of questions to which we don't know the answers, unfortunately, at the present time. But we hope, in due course, to get these answers.

**D. A. Swalheim:** As pointed out by Dr. Brighton, the results of the corrosion pack tests conducted by American Can Company show that considerable progress has been made in improving the quality of electrolytic tin plate during the past several years. The steel industry should feel greatly encouraged by the results obtained up to the present time with tin plate of much lighter weight coatings, representing a substantial saving in tin. We are all aware that the sources of tin metal are limited, and every effort should be made to conserve tin for future generations even when the tin supply again becomes available.

In confirmation of Mr. Timby's comments relating to steel base preparation, I would like to reiterate that adequate cleaning prior to plating cannot be overemphasized. The operation does not represent an appreciable cost item and, although the beneficial results of alkaline cleaning are not always visually detectable, its effect will eventually be established. Our experience during the war in aircraft bearing plating and other operations has demonstrated further the importance of adequate cleaning and pickling. In many instances, it has been necessary to employ several cleaning cycles to achieve minimum rejections.

Many of the investigations conducted on the effect of physical properties and chemical composition of the steel have undoubtedly shown that both affect the corrosion resistance of the electrolytic product more so than on hot-dip plate because of the much lighter weight coatings. It may be premature at the present time to attribute differences in corrosion resistance to variations in electrolyte because of effects of various other factors not thoroughly investigated.

Although the ultimate goal has not been achieved, remarkable progress has been made, and we are confident that electrolytic tin will become an established product for a wide variety of containers.

# TIN FUSION BY

# *Radiant Tube Heating*

***. . . . fusion of electrolytic tin plate by radiant tube heating gives a low fuel cost for the process, with quality comparable to that produced by other methods . . . .***

*by Howard L. Halstead*

ASSISTANT FUEL ENGINEER
BETHLEHEM STEEL COMPANY
SPARROWS POINT, MARYLAND

▲ AT the Sparrows Point Plant of Bethlehem Steel Company, fusion or reflowing of the tin coating which has been electroplated on steel strip is done in six radiant tube furnaces. Each of these furnaces is part of a brightening line where, in addition to the fusion of the tin coating, matte-finish tin plate undergoes several correlated treatments which are necessary to produce quality tin plate.

The fusion furnaces themselves are continuous two-pass tower furnaces. As can be seen from Figure 1, the strip enters the bottom of the furnace, passes up through the preheat zone, over the furnace head roll, down through the heating zone, and after leaving the furnace through a connecting chute into a water quench tank.

In its passage through the furnace the strip, which entered at a temperature of approximately 150 F, is heated just above the melting point of tin, or to approximately 450 F, causing the tin coating to melt, or reflow. Upon entering the quench tank the strip is rapidly cooled and the molten tin coating solidifies. By this fusion process the dull and relatively porous matte-finish tin coating is made bright and dense.

For convenience of description, the fusion furnace with its auxiliary equipment may be divided into several sections which are listed and described in the following:

1. *Industrial Carburetor* — Coke oven gas and air in correct proportions for complete combustion are mixed in an industrial carburetor and the resulting gas-air mixture is burned in the radiant tubes in the furnaces. At Sparrows Point one carburetor with a nominal capacity of 20,000 cu ft per hr of 500 Btu fuel gas serves two furnaces.

2. *Heating Zone* — The heating zone of each furnace contains two vertical rows of radiant tube heating elements, between which the strip passes. As is shown in Figure 2, each element has two horizontal firing legs which are connected by return bends. The return bend on one end of each element is made with both gas burner and exhaust connections, through which the gas-air mixture enters and the products of combustion leave the heating element. There are 17 heating elements, or 34 firing legs per row of tubes. The inside diameter of each leg is 5 in., the wall thickness ¼ in., and the outside diameter 5½ in. The elements are made of alloy steel containing 25 per cent chromium and 12 per cent nickel.

Because of the construction of the element and the momentum of the gas-air stream leaving the burner head, the products of combustion recirculate within the element. This recirculation tends to maintain uniform temperature along the full length of each firing leg. In addition, each firing leg passes through the side walls of the heating zone, thereby placing the return bends outside of the heating zone. In this manner, uniform heating across the width of the strip is assured and overheating of the edges of the strip is prevented.

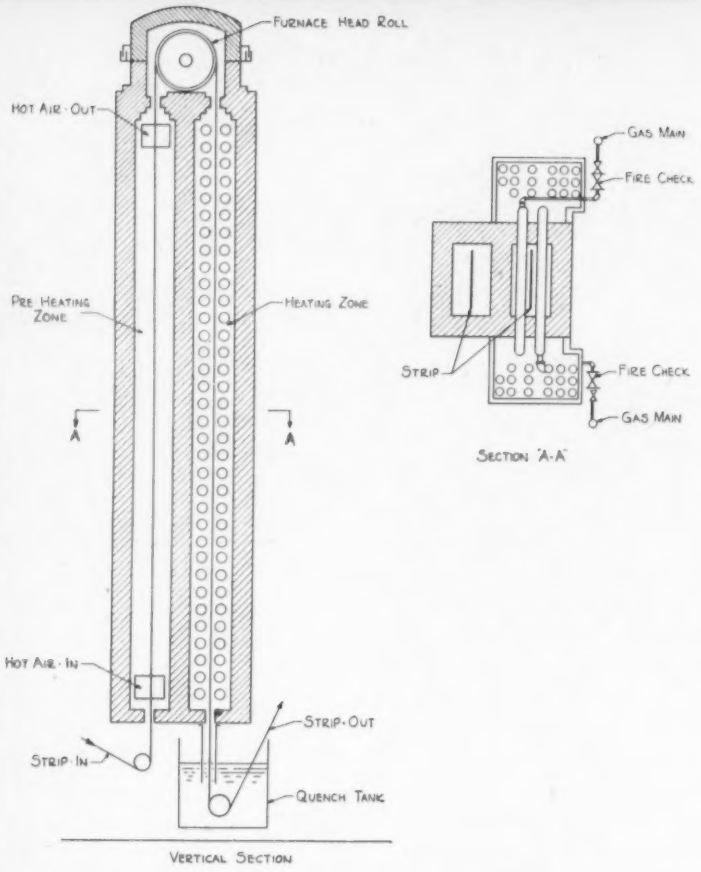
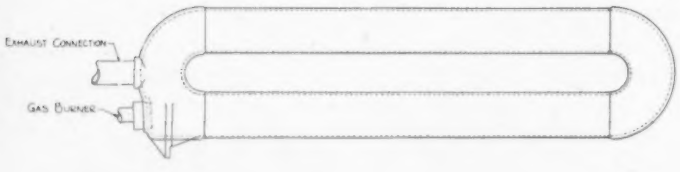



**Figure 1 — Radiant tube fusion furnace for electrolytic tin plate.**

▲

**Figure 2 — Radiant tube heating element used in fusion furnace.**




3. *Recuperative and Preheat Zones* — In the recuperative and preheat zones of the furnace the sensible heat in the exhaust products of combustion is used to heat recirculated air. This recirculated air, in turn, preheats the strip passing through the furnace.

The products of combustion leaving each exhaust connection enter a 2½ in. pipe which extends from the element to the top of the furnace. As may be seen from the horizontal section of Figure 1, these pipes are banked on two sides of the furnace and enclosed in an insulated duct, thus forming a tubular heat exchanger on each side of the furnace. Recirculating fans (not shown in the illustration) are connected to the bottom of each of the heat exchangers and recirculate air around the outside of the exhaust pipes and through the preheat zone of the furnace. Thus, the sensible heat in the exhaust is used to preheat the strip, and the strip is protected from direct contact with the products of combustion. There are two fans on each furnace, each circulating 3500 cfm of 650 F air.

4. *Instrumentation and Control* — Both the fusion furnace and the quench tank have automatic temperature control. The temperature at a point approximately 5 ft from the exit of the furnace is recorded on a single record potentiometer equipped with a pneumatic temperature controller which maintains constant furnace temperature by regulating the flow of gas-air mixture to the burners. On the quench tank an on-off controller automatically regulates the flow of cooling water. In addition, the temperatures of three other points in the heating zone, the temperature in the furnace head-roll chamber, and the temperatures at the outlets of the two recirculating fans are recorded on a six-point potentiometer.

These instruments, together with the other temperature recorders required for the brightening lines, are mounted on central control panels — one panel serving two brightening lines.

5. *General* — The overall height of the furnaces is approximately 36 ft. They are constructed of light weight refractory and as a result have a relatively low thermal capacity. The heating elements are supported from the structural steel work of the furnace.

## OPERATION AND PERFORMANCE OF THE FURNACE

The brightening lines are normally operated at a strip speed of from 270 to 280 fpm, and the speed of the strip is so adjusted that the product leaving the furnace is properly fused. The temperature required for proper fusion varies with the gauge of the strip, and the required setting of the temperature control-index is known for each gauge. The position of the control index will naturally differ for different furnaces and change over long periods of time. It is, however, constant enough for the operator to anticipate the control setting required for the gauge of the strip being fused. On one furnace, for example, the required setting of the control index changed from 1175 to 1300 F as the gauge of the strip changed from .093 to .124 in.

Once the line speed and the control index are set to fuse the tin coating properly, they are automatically kept constant and little adjustment is required by the operator of the brightening line.

The following tabulation shows the performance of one furnace for a specific size of strip.

| | |
|---|---|
| Size of strip, in. | 28⅝ x .093 |
| Speed through furnace, fpm | 275 |
| Square feet of exposed strip heating surface | 320 |
| Temperature of strip entering furnace, F | 150 |
| Temperature of strip leaving furnace, F | 450 |
| Rate of heat transfer, Btu per hr | 690,000 |
| Rate of heat transfer, Btu per sq ft per hr | 2,200 |
| Heat input to furnace, Btu per hr | 3,000,000 |
| Fuel rate, Btu per ton of product | 400,000 |

The quality of the strip which is fused by the radiant tube furnaces compares favorably with the quality of strip fused by other methods. This method of fusion results in a relatively low fuel cost per ton of product. We believe that the use of a continuous radiant tube furnace is a practical and satisfactory method of fusing matte-finish tin plate.

# THE *Mechanical Phase* OF *Open Hearth Steel* MANUFACTURE

***. . . . improvement in the mechanical factors of the open hearth process has given marked operating economies . . . . the unstable relation between the prices of scrap and pig iron act against new charging methods which might lead to heavier scrap charges . . . .***

*by Folke Sundblad*

ASSISTANT OPEN HEARTH SUPERINTENDENT
GREAT LAKES STEEL CORPORATION
ECORSE, MICHIGAN

▲ CERTAIN major wartime trends and developments have focused special attention upon a relatively little discussed aspect of the open hearth process — namely, its mechanical phase. Furthermore, the fast growing competitive strength of the plastic and lighter metal industries, the gigantic increase of the potential steel scrap supply in the postwar world market, and the elevation of the general wage level in the steel industry constitute factors necessitating still greater application of mass production technique in steel making.

When analysing our possibilities of meeting the challenge of these events, we find that the size and complexity of the problems involved have created a situation which automatically places us on the threshold of another chapter of open hearth history. It will be the third chapter.

The first chapter began, of course, in 1864 with the announcement by Pierre and Emile Martin that they had succeeded in making steel by melting iron and scrap together on the open hearth of a Siemens regenerative furnace. The second chapter began at the turn of the century with the introduction of mechanical charging, which not only gradually replaced manual methods with elemental machine technique, but also paved the way for deeper penetration into the various fields of steel making science. And as this work of specialization became more pronounced, it carried along a growing conviction on the part of every thinking member of the open hearth profession that the progress of the open hearth called for the greatest possible collaboration between the scientific and empirical minds.

I stress the growth of this new type of empiricism because it represents a modern force eminently needed in dealing realistically with the fact that certain economic conditions which constitute the very foundation of the open hearth process exercise today a far greater influence upon the development of the mechanical phase than they did in the past. I make reference to the technological effects of the fluctuations of the price of scrap relative to the production costs of pig iron. And because this economic relationship lies outside the jurisdiction of the engineering mind, any major change of the production technique affecting the basic trend of the mechanical aspect must be calculated on the basis of an unknown quantity, with the result that the effort, however sound from a technical standpoint, may be proved unsound in the light of this relationship. This unique situation is brought to the surface when attempting to find a workable solution of the postwar scrap problems involving a scrap supply of well over half a billion tons in a world market which will have lost its two best prewar customers — Germany and Japan.

Thus, while the engineering mind is able to design new open hearth charging systems based on new principles in order to take advantage of this enormous scrap

Presented before A. I. S. E. Detroit District Section Meeting, February 13, 1946.

supply, the question arises: Would it be compatible with sound technological and economic policies to install a charging system favoring high scrap percentage and low scrap prices, when the very efficiency of the system would create greater demand and higher scrap prices under present market rules, which in turn would automatically lower the competitive strength of the new system versus older methods?

The answer to this perplexing question requires a rather close examination of our relations with the scrap industry to be able to revalue the premises underlying this relationship. But in the process of correcting its negative features, we must be careful not to destroy the original foundations of this relationship, but rather strengthen them in the light of new production techniques and economic conditions.

Fundamentally, the mechanical phase of open hearth steel manufacture embraces three major functions: 1. To charge the furnace; 2. to handle and transfer materials? and 3. to supplement the chemical, metallurgical and physical aspects of the process.

From the standpoint of open hearth jurisdiction, however, it is appropriate to divide these three functions in two groups, because the nature of some of the problems involved is such that they necessitate the concentrated attention of highly specialized branches of mechanical science. Thus, one group includes problems, the development of which lies within the jurisdiction of the open hearth, and the other group is comprised of problems, the development of which lies outside the field of open hearth engineering. In this latter category belong problems dealing with the handling and transfer of materials as well as burner design.

The substantial increase of furnace capacity in the last two decades and the manpower shortage during this war have lent impetus to the process of introducing mechanical equipment of various types. Accordingly, we have to a large extent replaced wheelbarrows with tractors, trucks and traxcavators in moving alloys, bricks and similar materials. We have substituted pick and shovel work in cleaning slag pockets with bulldozers and pneumatic equipment ranging from giant size concrete busters to hand tools. We have replaced hand shoveling with automatic conveying methods, scrapers, back wall machines, and so on.

These innovations have reduced man-hours considerably. In some cases, particularly in regard to the cleaning of slag pockets, this reduction has undoubtedly amounted to several hundred per cent. In the case of moving materials from one point to another with use of a so-called car scoop, some interesting statistics were recently compiled by a Pittsburgh steel mill. For example:

On clays, 1/16 to 1/10 reduction in man-hours.
On silicon alloys, 1/6 reduction in man-hours.
On dolomite, 1/4 reduction in man-hours.
On lime, 1/4 reduction in man-hours.

But the greatest benefit derived from this wider use of mechanical equipment in general is perhaps its psychological effect, because this positive trend will undoubtedly serve as a future inducement to attracting the higher grades of labor to the open hearth.

In the light of these radical changes from handicraft methods to machine technique, most of which have taken place during this war, we can rightfully look upon this period as a period of transition between old and new eras of open hearth practice. But this conclusion is only partly correct when applied to the group of problems the mechanical phase of which lies within the jurisdiction of the open hearth.

In this case, it is true that we have reached advanced positions at some points, but on the whole, it must be admitted that we are still inside the borderline of the old era. And the reason for this is that the progress of this part of the mechanical phase is to a large extent proportional to the development of the charging function, the progress of which in turn is mostly due to the economic factors over which we have no control. We will deal with this point when discussing our relations with the scrap industry. At this time, however, it is desirable to make clear that the function pertaining to charging occupies such a pivotal position as to constitute the very nucleus of the whole mechanical phase, and naturally necessitates a thorough analysis, while the problems regarding the mechanical approach to the chemical, metallurgical, and physical aspects must be considered of secondary importance. Therefore, in discussing the latter phases, a few examples illustrating the part played by the mechanical mind to facilitate and hasten the chemical processes of iron and steel may suffice to give at least a basic conception of this relationship.

A very illuminating, and at the same time, very unique example of this effect is the almost totally forgotten process called the Ushatii process to eliminate sulphur from iron. It was invented by a Swedish engineer named Ushatius in the middle of the last century. The main feature of this invention was a wooden wheel equipped with a number of blades which were spinning around in a large box half-full of water. The idea was to direct the stream of molten iron from the ladle at the tip of the blades immediately before they dipped under the water, with the result that the metal was broken up in a multitude of particles which fell down in the water and formed hollow globules which proved to be sulphur-free. The sulphur combined with the hydrogen of the water to form $H_2S$. This process was in operation well over half-a-century in Sweden, where the product was mainly used in connection with the crucible steel process, but was also experimented with in the open hearth furnace.

As another mechanical approach to a chemical problem, one can include the invention of the tilting furnace in 1876, because it offered means to adjust the lime-silica ratio of the slag by elimination of undesirable slags besides enabling greater control of slag reactions. The characteristics of this type of furnace constituted the basis for the Talbot, Bertrand-Thiel, Thomas, Hoesch, and later years' triplex processes. From another standpoint, this type of furnace is of special interest to us because several present day inventions on overhead charging are based on the tilting feature of the furnace. The reason for this is that the objectives of these inventions are not only to be able to dump great masses of scrap into the furnace in a few minutes, but also to be able to create a modern duplex process, or rather, a modern version of the Bertrand-Thiel process, in which the charging and melting operations take place in one unit and refining in another. To accomplish this, a stationary furnace, is of course less suitable.

This potential development lends substance to the thought that the charging aspect far overshadows the other mechanical functions in importance, and can even determine the trend of the advancement of the whole process. This holds true whether the problem concerns a mechanical pouring device improving the quality of the steel, or a water-cooled damper or port facilitating combustion, or any other of the multitude of mechanical improvements affecting the metallurgical and physical aspects.

Inasmuch as it is now half-a-century since Samuel T. Wellman introduced his first charging machine at Homestead, Pennsylvania, in 1895, we can fully appraise the value of this invention in its true perspective. And by analysing the effects of his charging system upon the present cycle of steel making from 1900 to today, we can get a rather clear picture of the technical and economic potentialities of the next open hearth cycle.

Wellman's invention marks the beginning of a new era of the open hearth for several reasons. To begin with, it should be observed that the idea to transfer scrap mechanically into an open hearth furnace was conceived at a time when the products of the bessemer converter had begun to increase materially the scrap supply of the country. And since the bessemer can only use a fraction of the scrap it produces, or about 5 per cent, while the open hearth can use a very large percentage, it meant that the open hearth process had gained a vitally important point from the competitive standpoint in its race for supremacy with the bessemer process.

In the second place, mechanical charging greatly affected the current trend of open hearth thinking. Up to the time this new invention has proven its practical value, the delivery of the scrap into the furnace was a very slow and cumbersome operation. It was performed by a crew of men placing the pieces of scrap on a long paddle which was pushed into the furnace by another crew of men. As a result, one school of thought argued that the only salvation of the open hearth process in its competition with the bessemer was development of means to reduce drastically the scrap percentage of the charge. In short, their thinking followed along practically the same lines as the ones we have followed since 1940 on account of the wartime scrap shortage, and it must be admitted that their penetration into the subject of high iron charges was indeed remarkable.

Another school went a step farther and recommended that no scrap at all should be used in the open hearth. Instead, open hearth steel should be made directly from iron ore. Representative of this trend of thought from that period is the Rudolph and Landins process, in which pulverized iron ore and coal and a binding substance were pressed together into briquettes which in turn were sintered and finally melted in an open hearth furnace.

Still another important effect of using machine technique in charging was that it became possible to charge and melt the material at the same time. In other words, instead of succeeding each other, the two periods began to overlap, and consequently we can speak of a certain time ratio between the two phases — fairly constant all these decades because every improvement regarding efficiency and speed of the charging equipment has been counter-balanced by improvements in matters concerning furnace design and combustion. Besides, for many years — or from about 1900 to the beginning of the 20's — outside factors governing the scrap supply proved the nemesis of attempts to gain a more ideal relationship between charging and melting periods. Thus, for instance, as long as the railroad, farm implement and building industries were practically the sole scrap suppliers, comparatively little progress could be made in reducing the time factor. This particular scrap, when charged, does not expose large enough surfaces per given weight, and considerable time is therefore required to transform it from solid to the molten state.

But the real reason why Wellman's invention proved to be an epoch-making event was that it paved the way for mass production technique in steel making, which not only made it possible to increase the furnace size by several hundred per cent, but also created the modern version of the scrap market. In view of this latter relationship, our interpretation of open hearth charging technique becomes a matter of dealing not with different types of charging machines, whether low, high or crane types, but with the principles underlying different charging systems, because the application of these principles corresponds with certain changes in the scrap market.

Thus, from 1900 to 1920, roughly figuring, one used only the principle of lifting the scrap into the furnace. From 1920 to the present day, one began developing methods based on the principles of conveying, pushing, and dumping the scrap into the melting unit.

When the principle of lifting is employed, the scrap is loaded in boxes, a number of which are placed on a buggy. The box is lifted into the furnace, turned over and brought back on the buggy by the charging machine. Experience has proved that this system of charging has several weak points from mass production standpoint. In fact, it has reached its efficiency limit in several respects. For instance, the box has a definite size limit because, if too large, it cannot be turned over in a half-filled furnace. Moreover, the transfer of the scrap from the yard via the charging machine into the melting unit offers uncalculated chances for delay to the operation as a whole. And since this operation depends mainly upon the synchronized movement of hundreds of buggies passing over the charging floor, it stands to reason that any interference to this traffic in the form of broken buggies, scrap on the tracks, etc., detrimentally affects the production schedule.

It is also axiomatic that the size of this traffic or the number of buggies to be charged is in direct proportion to the volume of the scrap. In other words, the character of the scrap has a decisive bearing upon the efficiency of this method, and for this reason this method proved perfectly satisfactory in the period when the heavy melting steel scrap from the railroad, building and farm industries constituted the biggest percentage of the scrap supply.

In the 20's, however, when the American scrap market underwent a revolutionary change which was brought about principally by the spectacular growth of the automotive and container industries, and by a marked recession on the part of the old scrap-supplying industries, this method of charging commenced to show signs of having outlived its own usefulness. The light,

bulky scrap which began flooding the market emphasized the weak points of the system.

In order to overcome the disadvantage of lifting light, bulky scrap into the furnace, this type of scrap is generally introduced in bundled form. The result, naturally, is a speeding up of the charging operation to the same degree that melting is slowed down. The detrimental effect of this practice is directly proportional to the size of the furnace, because the tightly compressed, hard-melting bundles force one to divide the filling-up period into alternate periods of charging and melting, and obviously, the bigger the charge, the greater the need for periods of melting. Consequently, when the furnace capacity has reached a certain figure, it is evident that the filling-up period will also have become so long as to make the time required by charging plus melting quite prohibitive.

In many respects one can compare this milestone in the evolution of the scrap market with the one a quarter of a century before when the scrap from the bessemer process drastically increased the scrap supply and induced Wellman to invent machine charging. One can rightfully say that the tremendous increase of the nation's scrap supply, together with the equally important change in the nature of the scrap which took place in the 20's, created almost as great a need for a new approach to the charging problem as for the one introduced by Wellman relative to the old hand charging method. And inasmuch as the efficiency of the charging method determines to an overwhelming degree the development of the mechanical phase as a whole, it naturally follows that this scrap situation has a vital bearing upon our subject. What is more, by analysing the factors which prevented the engineering mind from taking proper counter measures, we will better understand our position in the gigantic scrap problems facing us after the war.

In regard to fundamental changes in the American scrap market in the 1920-1940 period, they were brought about, as has already been pointed out, by the rise of the automotive and container industries and a number of similar consumers of semi-fabricated steel, and by the decline of the older major industries consuming finished steel in the form of rails, pipes, structural shapes, etc. So greatly did this change in the steel market affect the potential scrap supply of the nation that it produced two additional major sources of steel scrap. In the old days, when the industries of the latter group took the lion's share of the steel production, the steel did not come back to the scrap pile until after 20-40 or more years, but in the 1920-1940 period, when the biggest part of the steel production left the mill in semi-finished form, whether it was for the automotive, container, refrigerator, furniture, electrical appliance or other similar industries, approximately 10 per cent became scrap immediately in the finishing processes, while the life span of the finished product was shortened to one to 20 years.

In other words, the country's steel scrap supply was filled since 1920 through four distinctly different inlets:

1. Scrap produced in the steel mill.
2. Scrap produced in the finishing process outside the mill.
3. Short-cycle steel scrap (automotive, etc.).
4. Long-cycle steel scrap (rail, pipes, etc.).

Altogether, these sources of potential steel scrap produced in an average year of the last decade — say 1936 — between 38 and 40 million gross tons. If we deduct the scrap produced in the steel mill, or 15,685,415 gross tons, we find the annual supply reached between 22 and 24 million. In that year (1936) the steel manufacturing units in the United States purchased 12,319,386 gross tons of domestic scrap (the imported amount was very insignificant). Consequently, the country produced a surplus of well over 10,000,000 gross tons of steel scrap.

How to dispose of this tremendous annual surplus became the subject of most intensive study, not only by the scrap and steel industries, but also from a national economy standpoint. As a result, we can register three widely separate lines of reasoning during this period of readjustment which have an all-important bearing upon our subject.

From the scrap industry's viewpoint, this scrap surplus created an abnormal economic condition which disturbed the delicately balanced ratio of supply and demand and therefore constituted a direct threat to the entire scrap price structure. Under normal conditions, the law of supply and demand caused price fluctuations to follow certain curves which were parallel with those of mill operations. For instance, whenever steel mill operations reached somewhere around 75-80 per cent of capacity, this law inevitably tended to raise the scrap prices. On the other hand, when No. 1 heavy melting steel scrap price went down below the production costs of pig iron, the sources of supply generally had a tendency to dry up. It did not pay scrap collectors to gather scrap unless they could make a reasonable profit over and above transportation costs, segregation, preparation and loading.

Under these circumstances, the logical move from the scrap industry's standpoint was to adopt a policy favoring total elimination of the scrap surplus. Accordingly, we exported over 20 million gross tons of the better grades of steel scrap from 1933 to 1940, and buried the lower grades, or approximately 70 million gross tons, in the dumping grounds of every city, town, village and hamlet.

From an engineering viewpoint, the scrap surplus presented a problem unique in the respect that its technical potentialities, however great and far-reaching, were hopelessly overbalanced by factors emanating from the circumstance that the open hearth process is primarily based on the relationship between the production costs of pig iron and scrap prices, because this relationship determines the ratio of scrap to pig iron of the charge. Thus, in times of low scrap prices, sound business judgment obviously calls for using as big scrap percentage as possible, and vice-versa. In our particular case, the scrap surplus was partly responsible for a scrap situation which favored as great a scrap percentage of the charge as possible. The question then arose: Could a charging system which had already reached its efficiency limit properly handle this additional load? The consensus among open hearth men indicated a negative answer.

Likewise, it was generally agreed that this scrap situation necessitated entirely new approaches to the charging problem. As a logical sequence, new methods based on the principles of conveying, pushing and dumping the scrap into the melting unit were created.

For example, Ford Motor Company installed a rather intricate system in which an entire automobile body was compressed into a bundle which was conveyed to a point in front of the furnace, into which it was pushed through a greatly enlarged door opening by the charging machine.

Another example is the J. O. Griggs' top charging method by means of a removable roof and a drop bottom box, handled by overhead crane. The roof is hinged on the backwall buckstays and can be raised to a vertical position during charging. The scrap is transferred in a large box or bucket, the size of which is comparable with that of the roof opening. The time required for the whole charging operation — that is, hoisting the box to a position above the roof, opening and emptying — amounts to only a few minutes.

Still another system of mass charging has been introduced by the Wellman Engineering Company. In general, this method requires a furnace with a removable front which is substantially as long as the hearth and which can be readily extracted to permit the delivery of the scrap in bulk. The charging equipment consists of a specially designed charging machine and a large scrap container or pan having a flexible rolling bottom. In charging, the loaded pan is placed on a frame and run into the furnace the full distance. Retraction is immediately commenced, and while being retracted the pan floor is caused to roll underneath the frame, thus unloading the scrap.

These and other pioneering efforts to advance modern charging technique have greatly contributed in establishing a definite trend of thought which emphasizes that we have reached a stage in the evolution of tonnage steel-making wherein not only changing technical and economic conditions demand a drastic departure from old standard methods, but also that the progress in other fields of science has brought such a development within the realm of possibility.

Aside from the purely technological effects of new approaches to the charging problem, this development has also brought out the economic aspects of advanced charging technique. We find that, although one of the principal objectives of greater mass production technique in charging is to encourage the use of scrap, it stands to reason that it would create a greater demand for scrap, which in turn, according to the law of supply and demand, would raise the price of this material. When this price would reach a point high enough above the production costs of pig iron as to make it more profitable to use a lower scrap percentage of the charge, it is quite obvious that such a technical development would be contrary to sound engineering and economic policies. Consequently, the potential existence of this vicious circle stresses the point that the primary prerequisite for a successful solution of the charging problem, as well as of the scrap surplus problem, is a properly balanced and stable ratio between the price of scrap and the costs of pig iron.

In the light of this situation, a new economic school of thought attacked this problem from a vastly different angle. It argued that, however prominent a position steel scrap occupied in the prewar period, its future role would become still more vital to the nation due to the alarming rate at which high grade iron ore deposits are dwindling. Therefore this problem is a matter of national concern and consciousness, and must become part of a national program dealing with the development and preservation of national assets.

And to bring about a relationship between the price of scrap and the production costs of pig iron which is sound enough and stable enough to induce promotion of greater mass production technique in charging and melting periods, the economic and technical aspects of the scrap problem must be altered to meet modern standards. In short, from an economic standpoint, the profit motive must be subordinated to the production motive to such an extent as to totally eliminate speculative influences upon the rise and fall of this price. From a technical standpoint, the scrap yard must become a modern processing plant handling collection and preparation on the basis of scientific surveys and mass machine technique.

It is to be observed that this reasoning, however idealistic it appeared 15 or 20 years ago, is now in the process of being materialized thanks to war time economic conditions. We find that the United States is rapidly becoming scrap conscious. Scrap collection has improved to a point where it is beginning to meet modern standards. National scientific surveys determining the supply and demand of scrap constitute the basis for scrap collection and distribution. Container scrap is no longer wasted, but is scientifically treated in order to retrieve the tin as well as making it useful from a scrap standpoint.

Whether or not this positive trend is to be extended into the postwar period depends upon the success of our present efforts to work out a definite plan to serve as a guide for postwar decisions pertaining to the future relationship between the steel and scrap industries versus the scrap situation created by the war. The postwar scrap problem centers on these points:

First: That an overwhelming degree of the total world finished steel production, the annual amount of which has been between 80 and 100 million tons since 1939, will constitute potential steel scrap. The biggest percentage of this tonnage, together with the tonnage in wrecked buildings, bridges, railroads, etc., will be either in Europe or Asia.

Second: That a major percentage of this potential scrap supply is the property of the United States government.

Third: That the preparation, segregation, transportation to and loading on American boats offer practical means of reversing lend-lease commitments, or that the price of this scrap in American ports would amount only to the cost of freight plus the price fixed by the United States. The prewar freight rate (1936) from England to the United States was 22 shillings 6 pence per gross ton, or a little more than $5 per gross ton, and this rate, according to the U. S. Department of Commerce, would have been considerably lower had there been a greater movement of this commodity.

It should be observed that the scrap price thus stipulated would also govern the price in the domestic market. For this reason, the price-fixing policy of the government covering the foreign scrap must be made in the light of this relationship as well as in the light of the production costs of pig iron. In other words, the established price must be low enough to be within a proper range of the costs of pig iron, and high enough

to cover the base price plus the costs of collection, processing, loading and transportation, plus the profit regarding domestic prices. This can be accomplished on one hand by regulation of the base price, not by the government but by the scrap industry in conjunction with the government, according to policies dealing with the movement of scrap, and on the other by the fact that this setup would totally eliminate speculation in scrap.

All of these potentialities would make possible a stable and sound scrap price relative to the costs of pig iron, which means an entirely new basis for the open hearth process. On this new foundation, the development of the mechanical phase is destined to enter a new era of progress.

# DISCUSSION


**PRESENTED BY**

**P. E. HAGLUND, Melting Superintendent, Ford Motor Company, Dearborn, Michigan**

**F. W. SUNDBLAD, Assistant Open Hearth Superintendent, Great Lakes Steel Corporation, Ecorse, Detroit, Michigan**

**H. F. LESSO, Open Hearth Control Metallurgist, Great Lakes Steel Corporation, Ecorse, Detroit, Michigan**

**A. F. DANZER, Superintendent, Great Lakes Steel Corporation, Ecorse, Detroit, Michigan**

**H. E. PHELPS, Superintendent, Electric Furnace Department, Rotary Electric Steel Company, Detroit, Michigan**

**R. E. DIENST, Great Lakes Steel Corporation, Ecorse, Detroit, Michigan**

**GARRETT BURGESS, President, Garrett Burgess, Inc., Detroit, Michigan**

**L. R. MILBURN, Electrical Engineer, Great Lakes Steel Corporation, Ecorse, Detroit, Michigan**


**P. E. Haglund:** I would like to hear a little more about cleaning slag pockets. About what is the average time to clean a slag pocket?

**F. W. Sundblad:** At Great Lakes Steel Corporation we are able to clean a slag pocket, having approximately a three-foot layer of slag, in 8-12 hours under average conditions. The size of the pocket is about 18 x 17 ft.

We use a specially designed machine, a portable crane with a pneumatic hammer attached to the boom. The hammer is telescopically operated along the boom. The machine is also equipped with a specially designed scraper. The machine is a product of Great Lakes Steel Corporation.

I may add that the slag-breaking operation is greatly facilitated by having a thick layer of sand on the bottom of the pocket as well as by having the pocket divided in two or more sections. A two to three foot high tunnel, or so called "dog-house," serves this purpose very well.

**H. F. Lesso:** It was stated that the size of a charging box controlled to some extent the efficiency of the present charging operation. I believe Jones and Laughlin Steel Corporation has made some studies in that respect and has found that they could increase the size of the charging box from 28 to 35 cu ft, the latter size being more efficient. In this way they were able to charge a 200 ton furnace in 45 minutes. How large do you think a charging box could be made?

**F. W. Sundblad:** I stated that inasmuch as the charging box has a definite size limit — if too wide or deep, it cannot be turned over in a half-filled furnace — the present charging system has a definite efficiency limit. It stands to reason that the closer we come to the ultimate size limit of the charging box, the more efficient becomes the charging operation, but this trend is more or less counterbalanced by factors dealing with the type of home scrap, heat loss, feasibility of increasing the distance between the buckstays and of raising of the roof, etc. Therefore, the size of the charging box must be determined in the light of these factors which vary considerably in each specific case. For instance, in the case of Jones and Laughlin Steel Corporation, whose charging record you mentioned, it should be observed that its home scrap situation is exceptionally favorable from charging standpoint, thanks to its high percentage of duplex operation. In other words, they are able to use an abnormally high percentage of blooming mill scrap. This fact, together with the equally exceptional circumstance that they are able to use two machines at the same time when charging a furnace, constitute an ideal setup for the present charging system.

Another example illustrating the varying factors determining the speed of the charging operation relative to the size of the charging box is furnished by the Ford Motor Company, which has a furnace equipped with unusually large doors. I believe one of their furnaces is equipped with 9 ft doors.

**P. E. Haglund:** That is our No. 10 furnace, where we charged scrap automobiles in the past. Its doors are 67 in. x 106 in. Some of the other furnaces also have large doors which permit us to use charging boxes of extraordinary sizes. The largest box is 25 in. x 46 in. x 83 in. inside dimensions.

**H. F. Lesso:** I believe Ford had to increase the size of their door frames, redesigning their furnace fronts from the conventional five-door furnace to four-doors.

**F. W. Sundblad:** You have to have about half-a-foot clearance between the box and the door frame, and the wider the box, the greater the chances of harming the roof when turning over the box in a half-filled furnace.

**H. F. Lesso:** You spoke of the vast tonnage of scrap which will probably be made available to the steel industry in the United States from the battlefields of Europe. Suppose this scrap were delivered to one of the United States seaboard ports. How would you set up a price base system so that all the consuming centers would take advantage of it?

**F. W. Sundblad:** That is a hard question due to its highly controversial nature. Perhaps Mr. Danzer could give us his views on the subject.

**A. F. Danzer:** I understand the ideal for which you are striving, but the scrap market is a particularly touchy and variable market. It has been described to be a far more touchy market than the ordinary stock market; your suggestion would be equivalent, I believe, to government intervention in private enterprise.

**F. W. Sundblad:** But the point I stressed was that as long as most of the scrap belongs to the United States, they would have the right to stipulate the price.

**A. F. Danzer:** That raises the question right there as to what belongs to the United States and what does not. Going back in history a little bit, we of course relinquished all ownership to anything we ever put over in the European countries. As to bringing it back, that presents two or three different features.

I have had some experience in bringing some scrap back from Africa. We found that some of the consumers on the eastern seaboard did not care to have anything to do with it, due primarily to the fact that there was alloy contamination. So we had to go ahead and urge the scrap dealers to accept it, because it was extremely costly to cut up some of the heavy armor plate, tanks, and so forth.

So as far as price is concerned, there is a whole lot to be ironed out before that ideal of which you spoke could be reached.

**F. W. Sundblad:** My point was that we should let them prepare, process and load the scrap over there. In that way they can partly repay the lend-lease debt.

**A. F. Danzer:** That suggestion has much merit, but it amounts to subsidy of the scrap.

**F. W. Sundblad:** Indirectly, yes. But considering the tremendous potentialities involved — positive from the standpoint of the steel industry and more or less negative from the standpoint of the scrap industry — the question regarding the relative importance of the two industries from national standpoint becomes of special significance.

**A. F. Danzer:** The scrap industry, of course, is one of the main sources of raw materials for the steel industry, and because of the price of scrap and its availability in large quantities, we have had the development of the melting practices of today. Some think we are perhaps too dependent upon scrap. Several companies have gone quite a way into the matter of synthetic scrap.

**F. W. Sundblad:** There is another angle to the scrap problem worth emphasizing in this connection. Because our reserves of better grade iron ore are dwindling, the price of scrap is bound to exercise a far greater influence upon the future development of the mechanical phase of the open hearth than in the past. For this reason it is of paramount importance to take every possible advantage of the scrap situation created by this war, not only with the objective of increasing our scrap supply but also in regard to the possibility of achieving a stabilized scrap price relative to the production costs of pig iron, which in other words means a stronger economic foundation for the open hearth process.

**A. F. Danzer:** But you still have the economics of transportation of that material from far distances.

**F. W. Sundblad:** The figures here, according to the United States Chamber of Commerce, show the freight rate in 1936 was a little over $5 a ton from England to U. S. A. I did not use any later figures, because in 1937 and 1938 the tense international situation had an abnormal bearing upon the scrap movement.

**H. E. Phelps:** I would like to ask Mr. Sundblad if in this proposed method of changing the front wall over, would he not anticipate a lot of trouble?

**F. W. Sundblad:** Work has proceeded on this idea for a number of years. The plan calls for removing practically the whole front wall. It will take a number of years before it can put it into effect, but I believe the trend is toward some type of bulk charging. The biggest drawback with the present system is that we cannot enlarge the charge much more, unless we use two charging machines, and I believe the trend is to develop into larger units.

**R. E. Dienst:** I would like to ask Mr. Sundblad to elaborate a little bit more on the top charging process. How successful was it?

**F. W. Sundblad:** It has not been used yet. The idea of top-charging has been the subject of much concentrated thought in the last 20-25 years. Various methods based on the principle of dumping the scrap into the melting unit have been invented. It is to be observed that the adoption of bulk charging would necessitate, first, almost as great changes of the general layout of the open hearth building as those necessitated by the introduction of the present charging system. Second, the scrap prices must be stabilized to such a degree as to remain in a favorable position relative to the production costs of pig iron.

**Garrett Burgess:** Mr. Sundblad brought up a very interesting point in regard to mechanical handling of scrap in comparison with the previous method of labor handling. What effect has that had on the complete cycle of the charging and tapping time?

**F. W. Sundblad:** Mechanical charging had a revolutionary effect upon the relationship between the charging and melting periods of the heat, because it made it possible to charge and melt the scrap at the same time. This could not be done when charging by hand, simply because the paddle which was used for the purpose of delivering the scrap into the melting unit would naturally become overheated.

This ability to charge and melt simultaneously has of course greatly reduced the total time for the heat, but on the other hand I am inclined to believe that we have only scratched the surface in fully utilizing this possibility. This is particularly true in regard to bundled scrap. From the standpoint of transportation and present charging technique, a tightly compressed bundle is the ideal thing, but from a melting standpoint it is the very opposite. For this reason it is argued by those who favor a change of charging technique that a semi-compressed bundle of far greater dimensions than those of the present one would fill the need more satisfactorily. In other words, the scrap would be transported and charged in bundled form, but once inside the furnace, it would be broken up by mechanical means. Such a development would naturally also entail a drastic departure of our current conception of scrap transportation and handling.

**Garrett Burgess:** Have you any data on the time required in the furnace for the compressed bundle as compared with loose scrap?

**F. W. Sundblad:** One negative feature of charging tightly compressed bundles is that the bundles, even when pushed together, occupy considerable space. And since they are rather hard to melt, it is often necessary to quit charging and divide the filling-up period into periods of charging and melting. In the case of loose scrap this procedure wouldn't be necessary. As to the difference in charging time for these two types of scrap, it depends upon a multitude of factors, as for

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instance the traffic on the floor, the size of the charging box, scrap loading facilities, etc.

**L. R. Milburn:** After the war, will it be feasible to try to salvage the steel and tin from our tin cans? The tin prices will go down, naturally. I understand the only reason we are salvaging tin now is that there is no supply of tin.

**F. W. Sundblad:** Whether or not the salvaging of tin cans will be a paying proposition from the steel scrap standpoint depends to a large extent upon the progress made in modernizing scrap collection. More definitely, if we revert in the postwar period to the unmethodical prewar system, whereby an army of individuals working independently of each other was mostly responsible for the collection of this type of scrap, the answer is no. On the other hand, if we develop a system of scrap collection along lines drawn up during this war — that is, to base scrap collection on scientific surveys of the scrap supply, to establish rules and regulations pertaining to the segregation of tin cans on the part of the individual household, to apply mass machine technique to the process of collection — in that case I would say the answer is yes.

**A. F. Danzer:** I believe I might add something to Mr. Milburn's question. The Los Angeles By-products Company and the Vulcan Detinning Company have found it feasible prior to the national emergency to reclaim tin scrap.

**H. F. Lesso:** The average tin in our scrap up to six months ago was 0.003 per cent. At present it has reached to 0.006 per cent.

Mr. Sundblad's paper suggests the redesign of the open hearth furnace to accommodate greater quantities of scrap. As I understand it, there are only two ways to conveniently adjust the size of the furnace: to increase the length, or the depth. Which course is preferable in order to accommodate a larger scrap charge?

**F. W. Sundblad:** I would recommend lengthening of the furnace. It would be of greater benefit.

**H. F. Lesso:** By increasing the length of the hearth would oxidation loss in the material be higher than if the depth were increased? By increasing the length of the hearth you would expose a greater surface of the charge material to the direct oxidizing atmosphere.

**F. W. Sundblad:** But you could then increase the speed of the charging operation, and this in turn would somewhat counterbalance the increased oxidation caused by the added surface exposure.

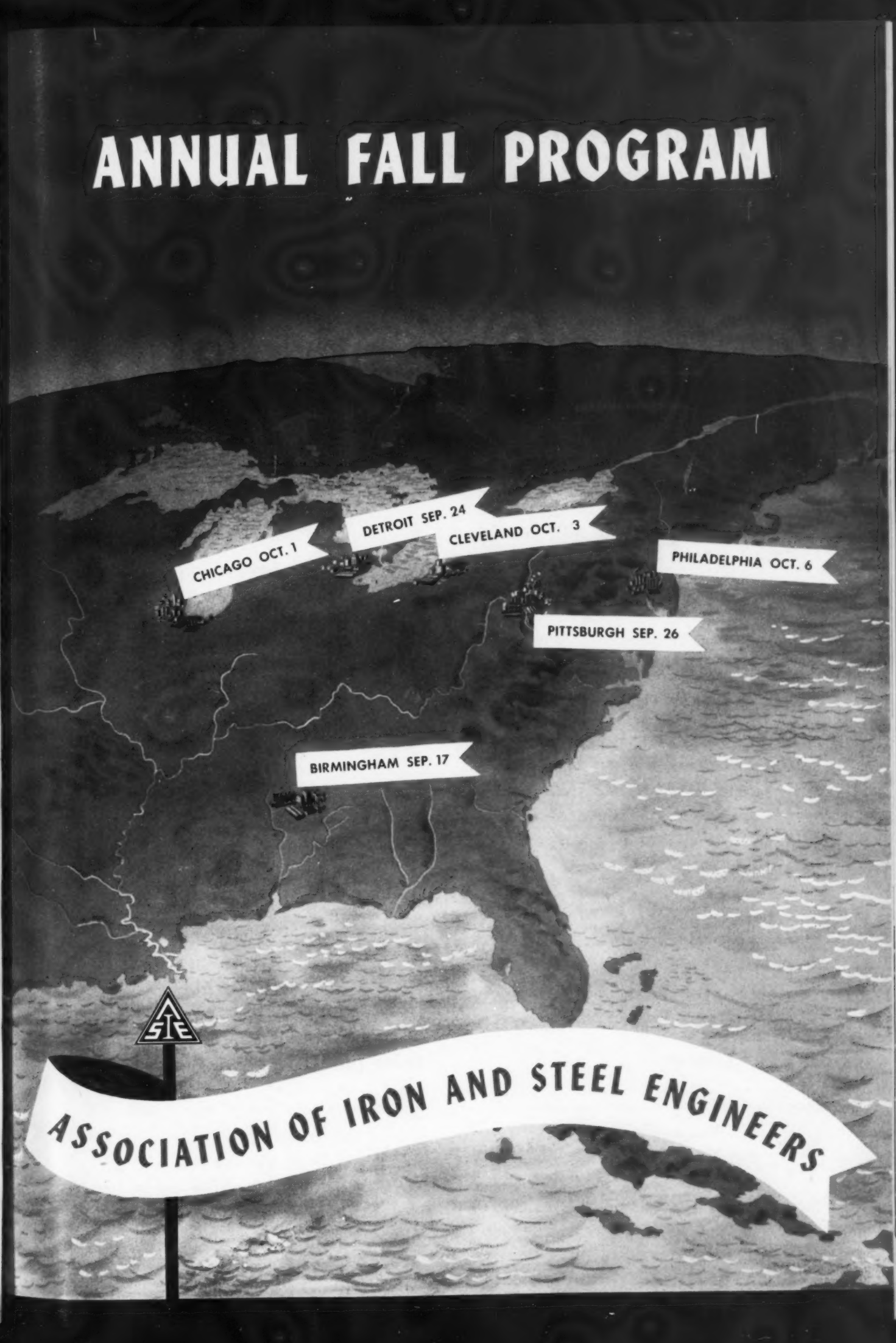
**H. E. Phelps:** If you increase the depth, would you decrease the time, or increase the time on refining?

**F. W. Sundblad:** The time would be increased. The operation would be slower.

**P. E. Haglund:** I might say we elevated the roof on two furnaces, and the change is working out very well and has not slowed up the furnaces or increased fuel costs. We raised it about a foot and a half on the back only, and it gave us considerably more space to hold the charge. It has not lengthened the time of the heats.

**L. R. Milburn:** Increasing the size of the open hearth means increasing the size of the ladle, runways, and cranes, and you run into trouble with the amount of metal you are trying to handle.

**F. W. Sundblad:** Yes, but one can use two ladles and a double spout.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# Birmingham

## September 17, 1945

Thomas Jefferson Hotel

### 9:00 a.m. Registration

### 9:30 a.m. Technical Meeting

**"Modern Conveying Systems in Steel Plants,"** by L. L. Horchitz and Paul W. VanOrden, B. F. Goodrich Company, Akron, Ohio

**"The Manufacture of By-product Sulphuric Acid from Hydrogen Sulphide in Coke Oven Gas,"** by W. A. Leech, Jr., Koppers Company, Inc. and F. D. Schreiber, Pittsburgh Coke and Chemical Company, Pittsburgh, Pennsylvania.

### 1:30 p.m. Technical Meeting

**"Rapid Heating of Steels with Gas Fuel to Heat Treating or Forging Temperatures,"** by Frederic O. Hess, President, Selas Corporation of America, Philadelphia, Pennsylvania.

**"Carbon Products in the Steel Plant,"** by Frank Vosburgh, National Carbon Company, Inc., New York, New York.

**"Blast Furnace Skip Hoists,"** by Gordon Fox, Vice-President, Freyn Engineering Company, Chicago, Illinois.

### 7:00 p.m. Dinner

Reservations for dinner must be made in advance to:

Mr. A. L. Lemon, Secretary
Birmingham District Section
Association of Iron and Steel Engineers
1722 First Avenue, North
Birmingham, Alabama

# Detroit

## September 24, 1945

Fort Shelby Hotel

### 9:30 a.m. Registration

### 10:00 a.m. Technical Meeting

**"Humidity Measurement and Control in Steel and Allied Industries,"** by O. J. Leone, Regional Manager, Steel Mill Division, The Bristol Company, Pittsburgh, Pennsylvania.

**"Blast Furnace Skip Hoists,"** by Gordon Fox, Vice-President, Freyn Engineering Company, Chicago, Illinois.

### 1:30 p.m. Technical Meeting

**"A Modern Electric Furnace Installation,"** by Frank W. Brooke, Vice-President, Swindell-Dressler Corporation, Pittsburgh, Pennsylvania.

**"Applying Fluid Drive in Industry,"** by G. V. Edmonson, Staff Engineer, Hydraulic Coupling Division of American Blower Corporation, Detroit, Michigan.

**"Modern Conveying Systems in Steel Plants,"** by L. L. Horchitz and Paul W. VanOrden, B. F. Goodrich Company, Akron, Ohio.

### 6:30 p.m. Dinner

Reservations for dinner must be made in advance to:

Mr. Elmer F. Weiss, Secretary
Detroit District Section
Association of Iron and Steel Engineers
2759 E. Grand Boulevard
Detroit, Michigan

# Pittsburgh

## September 26, 1945

Hotel William Penn

### 9:30 a.m. Registration

### 10:00 a.m. Technical Meeting

**"Causes and Cures of Transient Voltages on Distribution Systems,"** by G. D. McCann, Transmission Engineer, Westinghouse Electric Corporation, East Pittsburgh, Pennsylvania.

**"Friction Sawing, Past and Present,"** by James M. Lewis, Consulting Engineer, Kling Bros. Engineering Works, Chicago, Illinois.

### 2:00 p.m. Technical Meeting

**"Recent Developments in the Pyrometry of Liquid Iron and Steel,"** by H. T. Clark, Assistant Manager of Research and Development, Jones and Laughlin Steel Corporation, Pittsburgh, Pennsylvania.

**"The Spraying of Gear Lubricants,"** by D. E. Whitehead, Chief Lubrication Engineer, Carnegie-Illinois Steel Corporation, Pittsburgh, Pennsylvania.

**"Carbon Products in the Steel Plant,"** by Frank Vosburgh, National Carbon Company, Inc., New York, New York.

### 6:00 p.m. Dinner

Reservations for dinner must be made in advance to:

Mr. Brent Wiley, Managing Director
Association of Iron and Steel Engineers
1010 Empire Building
Pittsburgh 22, Pennsylvania

# Chicago

## October 1. 1945

Del Prado Hotel

### 9:30 a.m. Registration

### 10:00 a.m. Technical Meeting

**"Electric Drives for the Unitemper Mill — Their Selection and Operation,"** by J. D. Campbell, Steel Mill Division, Industrial Engineering Divisions, General Electric Company, Schenectady, New York, and J. G. McCurley, Electrical Engineer, Republic Steel Corporation, Warren, Ohio.

**"Rail Mills and Rail Mill Roll Design,"** by Ross E. Beynon, Superintendent of Roll Shop Division, Carnegie-Illinois Steel Corporation, South Chicago, Illinois.

### 2:00 p.m. Technical Meeting

**"Reclamation of Oils,"** by Jos. D. Lykins, Lubrication Engineer, Wheeling Steel Corporation, Yorkville, Ohio.

**"Some Characteristics of Blast Furnace Gas,"** by Owen R. Rice, Metallurgical Engineer, Freyn Engineering Company, Chicago, Illinois.

**"Development and Application of Twin Motor Drives,"** by G. E. Stoltz, Manager, Steel Mill Engineering Department, Westinghouse Electric Corporation, East Pittsburgh, Pennsylvania.

### 6:00 p.m. Dinner

Reservations for dinner must be made in advance to:

Mr. A. J. Whitcomb, Secretary
Chicago District Section
Association of Iron and Steel Engineers
58 E. Washington Street
Chicago, Illinois

# Cleveland

## October 3, 1945

Hollenden Hotel

### 9:30 a.m. Registration

### 10:00 a.m. Technical Meeting

**"Seamless Tube Piercing and the Problem of Making Steel Satisfactory for the Process,"** by Newell Hamilton, Superintendent — Steel Plant, The Babcock and Wilcox Tube Company, Beaver Falls, Pennsylvania.

**"The Manufacture of By-product Sulphuric Acid from Hydrogen Sulphide in Coke Oven Gas,"** by W. A. Leech, Jr., Koppers Company, Inc. and F. D. Schreiber, Pittsburgh Coke and Chemical Company, Pittsburgh, Pennsylvania.

### 2:00 p.m. Technical Meeting

**"Conservation of Utilities in Republic's Canton Plant,"** by P. L. Walter, Superintendent Mechanical Department, Republic Steel Corporation, Canton, Ohio.

**"Arc Furnace Switching,"** by L. W. Long, Engineer, Allis-Chalmers Manufacturing Company, Milwaukee, Wisconsin, and J. C. Chipman, Engineer, Allis-Chalmers Manufacturing Company, Boston, Massachusetts.

**"An Examination of Slow Cooling Methods,"** by J. William Barker, Staff Consultant, and Earl R. Cole, Engineer, Industrial Furnace Division, Loftus Engineering Corporation, Pittsburgh, Pennsylvania.

### 7:00 p.m. Dinner

Reservations for dinner must be made in advance to:

Mr. W. W. Spanagel, Secretary
Cleveland District Section
Association of Iron and Steel Engineers
16129 Euclid Avenue
Cleveland, Ohio

# Philadelphia

## October 6, 1945

Engineers' Society

### 9:30 a.m. Registration

### 10:00 a.m. Technical Meeting

**"Thermit Welding in Steel Plant Maintenance,"** by J. H. Deppeler, Chief Engineer, Metal and Thermit Corporation, New York, New York.

**"Rapid Heating of Steels with Gas Fuel to Heat Treating or Forging Temperatures,"** by Frederic O. Hess, President, Selas Corporation of America, Philadelphia, Pennsylvania.

### 2:00 p.m. Technical Meeting

**"The Sendzimir Precision Cold Strip Mill,"** by T. Sendzimir, Vice-President, Armzen Company, Middletown, Ohio.

**"Lighting Improvements and Developments for Steel Plants,"** by Davis H. Tuck, Professional Engineer — Electrical, Holophane Company, Inc., New York, New York.

**"The Spraying of Gear Lubricants,"** by D. E. Whitehead, Chief Lubrication Engineer, Carnegie-Illinois Steel Corporation, Pittsburgh, Pennsylvania.

### 6:00 p.m. Dinner

Reservations for dinner must be made in advance to:

Mr. Linn O. Morrow, Secretary
Philadelphia District Section
Association of Iron and Steel Engineers
Schaff Building
Philadelphia, Pennsylvania

# Continuous Pickler

# FOR COILED MATERIAL

*. . . . this new design, developed by Greer Steel Company and licensed for manufacture by the author's company, handles wide and narrow strip, rod, or wire . . . . experience has shown a fine operating record with good economy . . . .*

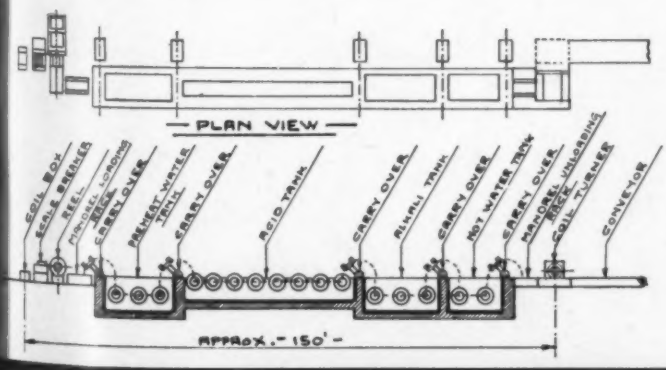
*by A. S. Hellstrom*

SPECIAL ENGINEER

THE ARMS-FRANKLIN CORPORATION

YOUNGSTOWN, OHIO

**Figure 1 — Plan and elevation for continuous coil pickler, showing arrangement of various units.**




▲ THE general practice of pickling steel for the market, either as hot rolled pickled material or for preliminary processing before cold rolling, falls under two general categories. The first method, batch pickling is by means of acid-resisting crates and tanks, operates with material in cut lengths or in loose coil form. The second method is by means of a series of acid and wash tanks through which the strands of strip steel are either pulled or pushed in ribbon form.

The Greer Steel Company developed and installed, in 1938 at their Anderson, Indiana, plant a unique third type of pickler for pickling strip and rods for their cold rolling department. This machine was developed with the idea in mind of producing large tonnages at a low operating cost, and with the use of a minimum amount of floor space. Continuous strand type picklers

require a floor space length of 300 to 600 feet, while the Greer installation requires a floor space length of 125 to 150 feet from the coil box at entry end to the coil upender at discharge end of line.

An idea was conceived whereby coils could be continuously pickled in loose form on mandrels and the Greer pickling line was developed around this idea, using automatic handling of coils through the pickling and wash tanks.

The present line at Anderson, in addition to a scale breaker and reel, has one 50 foot acid tank, one 23 foot alkali or cold water tank and one 18 foot hot water tank. All tanks are of concrete construction, lined with acid-resisting brick. Future installations will be equipped with a hot water preheat tank in front of the acid tank, which will increase the output materially. The line in operation at the Greer Steel Company plant is set to pickle from 20 to 30 coils or mandrels per hour, using 6-8 per cent by volume of 60 degree Be. sulphuric acid.

**Figure 2 — Strip material is run through a roller type scalebreaker at the entry end of the pickling unit.**

▲

**Figure 3 — Recoiled after passing through the scalebreaker, the material is put into loose coil form by backspinning.**

The method of pickling on this equipment is as follows: The coil is first passed through a special roller-type scale breaker which has a feed-in drive with overrunning clutches. After the strip has been threaded through the breaker, it is pulled through and rewound on a motor driven take-up reel block. This reel travels up to 400 fpm and thereby pulls the strip through the scale breaker at a high rate of speed, breaking the scale more completely than is the case when using a standard scale breaker or processor such as used in conjunction with the strand type pickling line. After the coil has been entirely wound up on an 18 in. diameter reel block, the block is reversed and the coil is back spun to a predetermined outside diameter, which assures a definite air space between the layers of strip when the coil is supported on the carrying mandrel.

After the coil has been completely back-spun, it is hydraulically stripped from the reel and moved into position in front of a cylinder which lifts the coil into a cradle. While in this position, a mandrel is inserted through the coil. The coil and mandrel next are taken from the loading rack by means of a fork-type carry-over mechanism, and are lowered into the acid tank. When the mandrel is released from the carry-over mechanism, its sprockets are engaged by a traveling roller chain and rack. The moving chain not only transports the coil along the length of the acid tank but also rotates the coil. Thus, although only approximately two-thirds of the coil is submerged in the acid bath, the rotation keeps all parts of the coil in contact with the pickling solution. Rotating the coil in and out of the acid bath tends to eliminate hydrogen binding or lock, resulting in greater efficiency and a better product. The present installation as now operating at the Greer

**Figure 4 — A mandrel is inserted into the coil and a fork type carry-over moves mandrel and coil into the acid tank.**

**Figure 5 — Coils and mandrels are rotated and moved through the pickling tanks by continuous roller chains.**

▲

**Figure 6 — General view of pickling unit from delivery end. Up-ender moves coils to roller conveyor which carries them to storage.**

plant permits the coils to remain in the acid bath from 30 to 20 minutes, assuring a delivery of 20 to 30 coils per hour. The number of coils which can be delivered from a pickling unit of this nature depends entirely upon the length of acid tank. Thus, lines can be designed to meet specific tonnage requirements.

After the coil has been completely pickled in the acid tank, it is lifted out of this tank by means of its mandrel and a fork-type carry-over mechanism, and transferred to the first water wash or alkali solution tank. In this tank the coil and mandrel are completely submerged below the liquid surface, and again are transported and rotated by means of a continuous roller chain. After the coil has been completely washed and has traveled the length of the first wash tank it is lifted from this tank by means of another carry-over mechanism and submerged into a hot water wash tank.

When the hot water wash has been completed, the coil with its mandrel is delivered to an upender cradle. Here the mandrel is extracted and the pickled coil is now ready for transportation by means of a roller conveyor to the desired destination.

In cases where it is advantageous to use large coils from 20,000 lb to 40,000 lb in weight for cold rolling processing, the welding and building up from smaller hot-rolled coils into one large coil can be accomplished after the pickling process is completed. Welding of pickled coils has been found to be superior to the welding of hot-rolled, unpickled coils.

This new type of continuous pickler is also being used for pickling narrow strip coils as well as wide strip. When narrow coils are processed a number of coils are hung on one mandrel and tonnage per mandrel is maintained.

Constant check of the operation of this design on strip steel shows that operation costs per ton of pickled soft steel on this type of equipment are considerably lower than on other types of picklers.

The unit can also be used for pickling rod and wire, in which case the mandrels are loaded with hot coiler coils, and the scale breaker and reel is eliminated from the line.

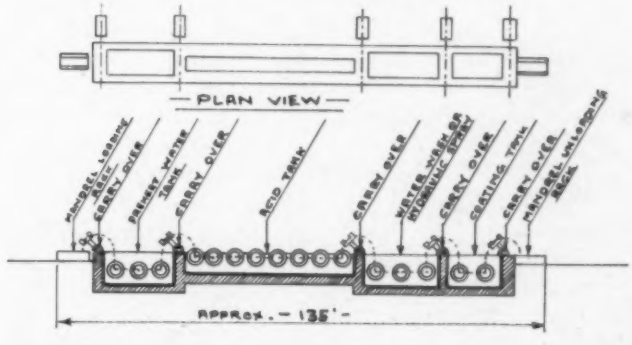
Electrical drive equipment used on the new design is as follows:

Scale breaker . . . . . 5 hp variable speed d-c motor
Reel . . . . . 50 hp variable speed d-c motor
Carry-over mechanism . . . . . 7½ hp a-c motor on each
Chain transfers . . . . . 3½ hp variable speed d-c motors

All motors, limit switches, and controls for coil travel and transfer are standard equipment.

Features offered by the new design include large tonnage capacity with small floor space requirements, low operating and maintenance costs, simplicity of operation, and high quality of product. A marked advantage of the unit is its versatility in handling wide and narrow strip, rod and wire in light and heavy gauges.

**Figure 7 — Sketch showing general arrangement of unit when installed only for pickling rod and wire.**



# PROGRESS IN *Switchgear Engineering*

***. . . . in spite of difficulties arising from wartime conditions, many developments have been made in switchgear . . . . some of these are still on the secret list because of war restrictions . . . .***

*by M. H. Hobbs*

MANAGER OF ENGINEERING
SWITCHGEAR AND CONTROL DIVISION
WESTINGHOUSE ELECTRIC CORPORATION
EAST PITTSBURGH, PENNSYLVANIA

▲ SWITCHGEAR activity, as well as that of other divisions, has been concentrated on the war effort for some time. However, war industries cannot operate without switchgear and control, and many designs developed solely for perhaps a secret Army or Navy project have been found adaptable to equipment for power station and industrial use, or have stimulated other developments along these lines.

First we might mention briefly some of the outstanding trends in practice and in switchgear apparatus as they appear at the present time, following with a more detailed discussion of equipment designs. This will perhaps be of value in your own postwar plans as it has been to us in laying out our program for development and apparatus design work. Recent trends include:

1. A reduction in oil content of oil circuit breakers, particularly high voltage outdoor types. This has resulted in somewhat less emphasis on breakers of the so-called oil poor or of the air blast type, although development work on these continues.
2. Higher speed of arc interruption and of protective relays. Five-cycle breakers for high voltage are now standard, and there is a definite demand for three cycles, which is also available.
3. Increased use of compressed air mechanisms for outdoor oil breakers, on account of the trend toward high speed reclosing.
4. A tendency toward air blast circuit breakers for indoor heavy power station switchgear at 13.8, 23, and 34.5 kv.
5. The use of magnetic blow-out air breakers for general power station and industrial use for 500,000 kva and below at 2300 to 13,800 volts.
6. A tendency toward factory-assembled switchgear for all low and medium voltage applications, and an appreciation by operating engineers of the effect of standardization and quantity manufacturing upon cost. This is, of course, not a new thought to steel mill engineers.
7. New developments in power and current limiting fuses and extended application of them.
8. The increased use of capacitors, even for applications formerly using synchronous condensers.
9. New developments in machine voltage regulation and excitation, involving rotating amplifiers, electronic regulators, and electronic excitation.

Presented before A. I. S. E. Pittsburgh District Section Meeting, January 8, 1945.

## OIL CIRCUIT BREAKERS

Last October a new oil circuit breaker of 115 kv rating and with reduced oil content was tested at East Pittsburgh for a number of visiting engineers. During these tests up to approximately 3,000,000 kva (3-phase equivalent) at rated voltage was interrupted. The breaker (Figure 1) was also demon-

strated to show its operation on 20 cycle reclosing duty. The tests showed particularly the small apparent effort on the part of the breaker and almost no external display, even though the fault currents ran as high as 15,000 amperes. Similar breakers have been tested as many as several hundred times in the laboratory, and from the results of these tests we have developed the complete line.

One of the actual oscillograms of the tests made in October is shown in Figure 2. This shows the reclosing shot, the first interruption taking place in 3.3 cycles and the second interruption is 4.8 cycles with a current of 7880 amperes, with a total time for the complete operation of only 23 cycles from the beginning of the current the first time until the arc extinction on the second opening. This shot was equivalent to about 1,600,000 kva, 3-phase.

The other two tests were interesting to show the consistent performance on both low and high currents: First a low current shot of 260 amperes, interrupted in 3.8 cycles, and finally a high current test of 15,000 amperes equivalent to 3,000,000 kva, 3-phase, which was interrupted in 3.5 cycles.

Of interest also was a test which occurred accidentally in the laboratory on a 161 kv breaker. Due to a combination of circumstances in the controlling cam switch, the breaker opened three times in 3.4 cycles, 4.2 cycles, and 4.0 cycles, and reclosed twice with reclosing times of only about 7 and 8 cycles respectively; in other words, a total time for the three openings and two reclosures of only 21 cycles of a 60 cycle wave. The current interrupted was equivalent to approximately 2,000,000 kva. Although we do not recommend such operation and it would not be possible with an arcing ground or short at this voltage, such performance does indicate the high efficiency of this form of grid.

This type of oil circuit breaker has been developed for voltages ranging from 115 kv to 230 kv and with interrupting capacities from 1,000,000 kva to 3,500,000 kva within a time of 5 cycles on a 60 cycle basis. A new form of de-ion grid, known as the multi-flow type, is used, which is so much more efficient than former interrupters that it is possible to reduce the tank size very appreciably, resulting in a breaker which is smaller, lighter, more easily installed and maintained, and requires less oil handling equipment than is the case for any other similar breaker of equivalent rating. The oil reduction from previous designs is about 50 per cent.

The cutaway view of the multi-flow grid in Figure 3 shows that it is made up of a stack of fibre plates within which the arc is interrupted by means of a flow of oil propelled by the upper pressure-producing break. This oil flow moves through vertical channels down to the interrupting chamber where it is forced laterally into all parts of the arc, the waste products being discharged through vents to either side of the grid. Since the moving contact fits closely within the fibre orifices, the oil flow de-ionizing the arc operates within very short breaker travel and the result, as shown by the oscillograms, is to clear the arc with very low arc voltage and little arc energy. Consequently, there is much less gas generated within the grid and the clearances around it can be reduced appreciably below those necessary for other types of interrupters.

The stationary and moving contacts are equipped with tungsten alloy tips to provide long life, and the burning of fibre plates is reduced to a minimum by the controlled flow of oil around all sides of the arc within the orifices. Side manholes in the tanks provide accessibility to the contact assembly.

The bushing current transformers for these breakers are made from strip wound cores of high permeability, low loss electrical steel.

Although the top rating of this line of breakers is at present limited to 3,500,000 kva, inquiries indicate that in the relatively near future 5,000,000 kva is more than just a possibility. The standard breaker is rated on a 5-cycle opening time basis. However, designs for 3 cycles are also available in 138 kv and higher voltages for 3,500,000 kva.

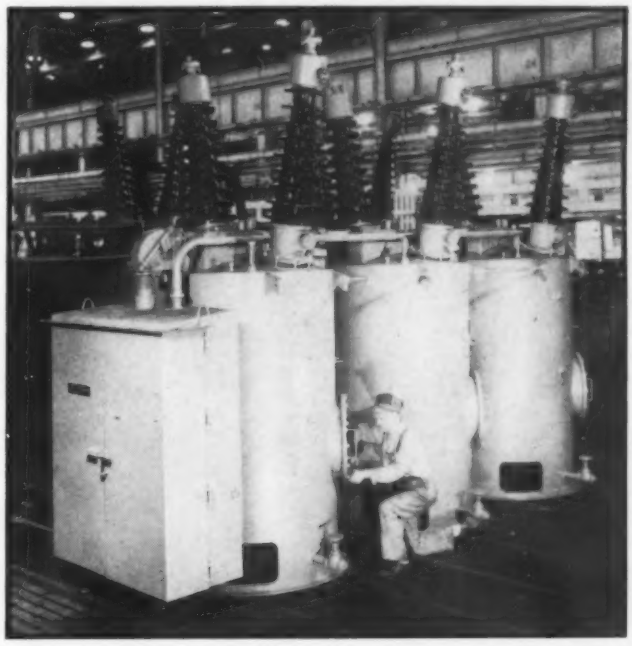
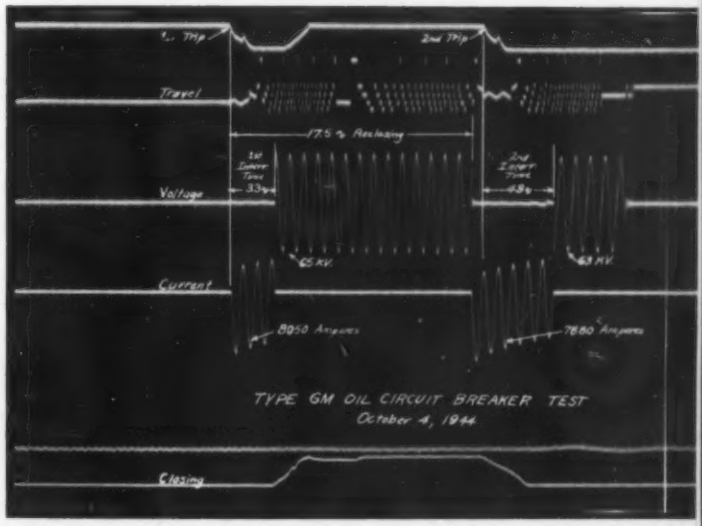


**Figure 1 — New type oil circuit breaker, 115 kv, featuring reduced size and oil content.**

▲

**Figure 2 — Oscillogram of reclosing test of 115 kv oil circuit breaker shown in Figure 1.**



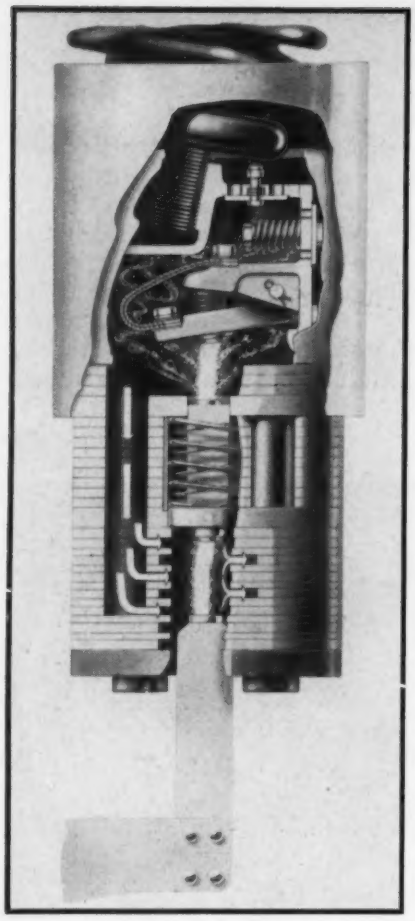


**Figure 3 — Cut-away view of multi-flow de-ion grid for 115 kv oil circuit breaker.**

### PNEUMATIC OPERATING MECHANISM FOR OUTDOOR BREAKERS

The compressed air mechanism used with the breaker provides for reclosure as quickly as within 20 cycles on a 60 cycle basis, which is very much faster than can be obtained with any conventional solenoid or motor mechanism.

It will be noted in Figure 4 that within the sheet steel housing there is included a motor-driven compressor and reservoir in which air is stored at 150 to 200 psi pressure with a quantity sufficient to give at least five closures of the breaker. The inlet valve magnetic coil is energized when the breaker is to be closed, and air forces the piston downward until the single mechanism lever is caught under its holding latch. At the same time an accelerating spring is compressed so that at any time it may become necessary to trip the breaker, the full opening speed will be obtained regardless of whether air pressure exists or not. Tripping is by means of a conventional shunt trip coil which breaks a latch.

Where reclosure is required, air is admitted to the operating cylinder during the opening stroke of the breaker so that reclosure actually starts before completion of the opening stroke, giving the high speed of closing shown on the oscillogram. Dumping of the air from the operating side of the piston takes place if the breaker is closed against a fault and must immediately open.

### INDOOR COMPRESSED AIR BREAKERS AND SWITCHGEAR

The indoor compressed air breaker was described and demonstrated sometime ago and will not be discussed in detail here. The trend seems very definitely toward compressed air for indoor heavy power station circuits of 1,000,000 to 2,500,000 kva at 15, 23, and 34.5 kv with metal cubicles for mounting which include the bus, disconnecting switches and current transformers as shown in Figure 5. Some 200 of these units have been built during the war period for large power stations and industrial plants.

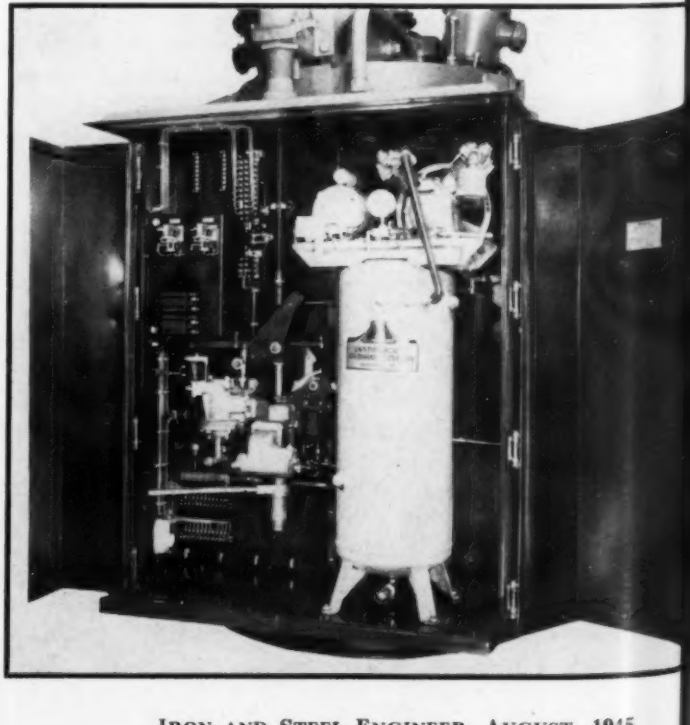
The mechanism compartment is accessible at all times by opening the lower doors. The upper doors giving access to live parts are interlocked with the disconnects so that they can only be opened when the disconnects are open. The bus is located at the top of the unit and the disconnects with their 6-pole group mechanism at the rear, interlocked with the breaker. Bushing current transformers are mounted on the disconnecting switch bushing.

### HIGH SPEED COMPRESSED AIR CIRCUIT BREAKER

A somewhat special application of the compressed air breaker, developed for the electrification of the Pennsylvania Railroad, is shown in Figure 6. It is designed for single phase 12 kv service and has an interrupting rating of 65,000 amperes which must be cleared within one cycle of a 25 cycle frequency.

A separate air supply unit, now shown in the photograph, contains an ample supply of air at 250 psi, from

**Figure 4 — Compressed air operating mechanism for outdoor oil circuit breaker, 115 kv to 161 kv.**



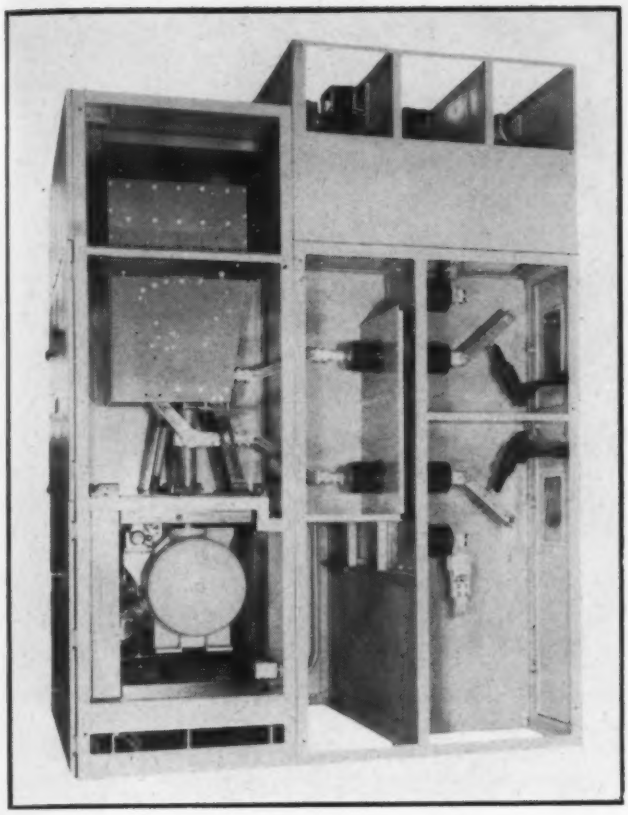
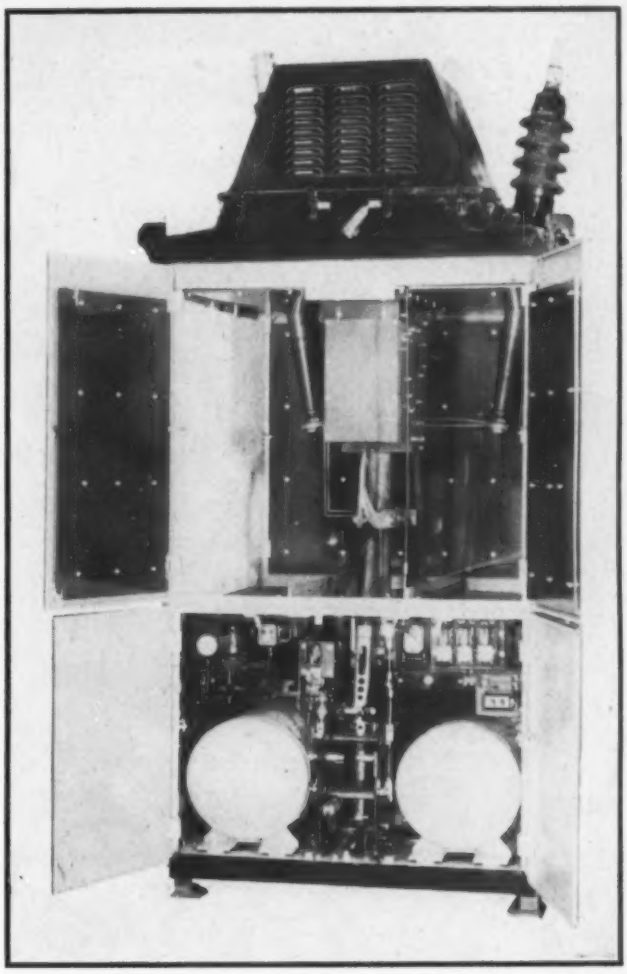


Figure 5 — Station cubicle switchgear assembly of compressed air circuit breaker, side view. ←

Figure 6 — Special application of compressed air breaker for single phase railroad service. ↓



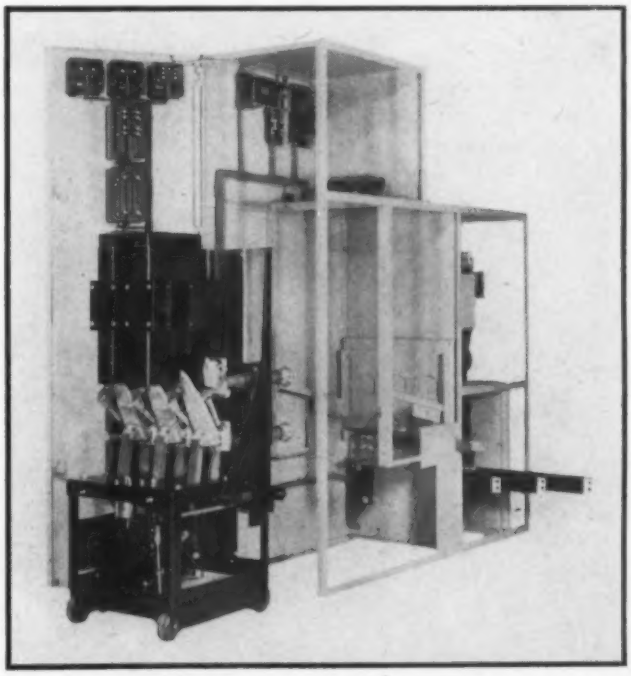
which air is drawn through a reducing valve to the local storage tanks associated with each breaker. This local air at 150 psi is sufficient for at least five breaker operations and provides the closing power for the breaker as well as the interrupting air blast. During the breaker opening stroke a cam operates to open the blast valve so that, at the proper time in the stroke, the air is blown up through the blast valve, past the contacts, and up into the large arc chute above. The action is very similar to that of the conventional 3-pole power house type of breaker except that it is designed for particularly fast interrupting time and high currents. Each breaker is mounted in its own outdoor metal enclosure with roof bushings for external connections with a current transformer on each bushing.

## MEDIUM CAPACITY SWITCHGEAR

For applications requiring 50,000 to 500,000 kva at 2300 to 15,000 volts, the trend is toward metal-clad switchgear with draw-out oilless circuit breakers of the magnetic blow-out type. Although the development began about 15 years ago, it is only in the last few years that it has started to crowd out the oil breaker. In Figure 7 the breaker has been stripped down somewhat for accessibility to the contacts, the right hand arc chute having been removed, as well as the barriers and the front steel plate. When ready for operation, these would be in place.

The standard base unit is designed for single bus operation with the bus, circuit breaker, current transformer, and cable terminals in separate compartments with grounded metal barriers between. The bus compartment is located so as to permit direct connections to the disconnecting contacts for maximum reliability.

Figure 7 — Metal-clad switchgear unit with 5 kv, 150,000 kva air circuit breaker.



Insulation for bus supports and bus covering is continually being investigated to find materials with the necessary insulation characteristics and improved fire resistance. Some of the new synthetic materials appear promising in this direction, but have not yet been proven.

Any of the standard indoor arrangements can be equipped for outdoor installation by adding weatherproofing details, and a great many unit substations and installations of this type for large industrial plants have been made during the war period.

### ANODE BREAKERS

For relieving mercury arc rectifiers and their transformers during backfire conditions, anode switching, due to its rapid action in limiting the duration and magnitude of backfire current, is a development of the war period and has been shown to be very effective. The anode breaker shown in Figure 8 is for application to rectifiers up to 3000 kw at 750 volts. One pole is used in each anode circuit, the poles tripping independently but closing from a common mechanism. This breaker, which occupies a smaller space than previous designs, will limit the peak of backfire current within .4 cycles of a 60 cycle wave and completely interrupt the fault at .7 cycles.

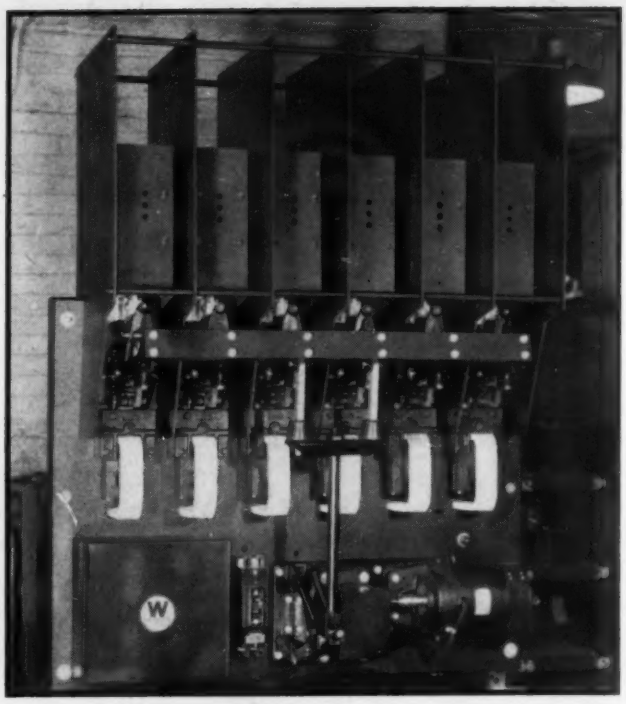


**Figure 8 — Anode air circuit breaker, 750 volts, 1600 amperes, for mercury arc ignitron service.**

### LOW VOLTAGE AIR BREAKERS

There has been very great activity in low voltage air breakers, both for industrial plants, and to meet the Navy requirements. The Navy activities, while mainly directed towards antishock features and requirements peculiar to naval combat vessels, have resulted in improvements that will be valuable to industrial and central station applications as well. Among these are new types of time delay devices incorporated in the breakers to achieve breaker selective tripping even at high values of short circuit current.

**Figure 9 — Metal enclosed switchgear unit for low voltage with electrically operated breaker.**

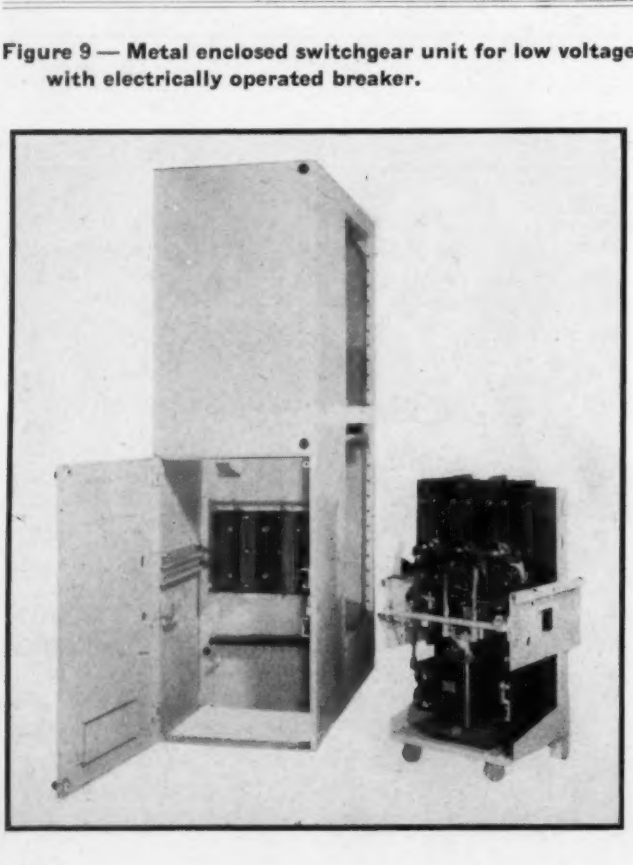
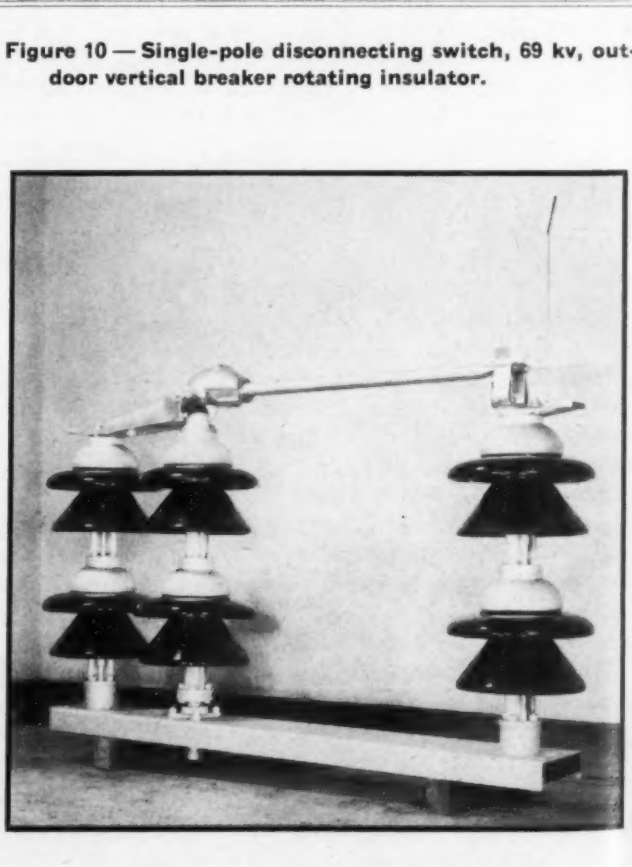


**Figure 10 — Single-pole disconnecting switch, 69 kv, outdoor vertical breaker rotating insulator.**



## LOW VOLTAGE METAL ENCLOSED SWITCHGEAR

Draw-out type low voltage metal enclosed switchgear such as shown in Figure 9 is now being used as general practice for generating station auxiliary circuits and many low voltage industrial installations. Five classes of low voltage breakers are available with interrupting ratings of 15,000, 25,000, 50,000, 75,000 and 100,000 amperes, and continuous current ratings up to 6000 amperes a-c.

The metal enclosed switchgear is constructed of individual units, any number of which may be bolted together to form a complete board and meet the most economical bus arrangement. Each front breaker compartment is completely isolated and the number of compartments in each unit is determined by the size of breaker (manual or electric), the interrupting rating, and the current capacity required. The metal enclosure for buses and cables at the rear of the board consists of universal frames available in depths of 6-inch steps, which provide flexibility in locating the buses, and mounting of accessories.

## DISCONNECTING SWITCHES

Several years ago an exhaustive study and critical analysis was made of all types and varieties of high voltage switches, including our own design. As a result of this study a new switch, easy in operation and simple in construction, has been developed, shown in Figure 10. It has only three moving elements and the juncture of these three elements occurs within an enclosed housing. In operation, the blade rotates completely out of contact before there is any movement about its hinge to the open position which results in easy operation. The switch shown is rated 69 kv, 600 amperes, and has a blade counterbalanced by a spring enclosed in the castings which join the two insulator stacks.

## FUSES

The line of power fuses has been extended to cover new fields of application. An outdoor fuse has been developed for application on systems up to one million kva at 138 kv. The fuse pictured in Figure 11 is a 115 kv fuse designed to be used principally on transformer primaries at isolated substations. The fuse is designed to drop out and provide a definite air gap in the circuit. It does not provide transformer overload protection, which should be obtained from secondary breakers.

The current-limiting fuse, an associated development, has been extended in rating to cover motor starting service and application to small auxiliaries connected to high power systems. The fuse is characterized by its high interrupting ability and its rapid limitation of fault current without the production of voltage surges. The fuse shown in Figure 12 is 5 kv with an interrupting rating of 60,000 amperes. The 200 ampere carrying capacity is obtained in a single 3 in. diameter tube.

## LIGHTNING ARRESTERS

Lightning arresters are now available for circuits from 110 volts for signal circuits to 287 kv for any machine or circuit application. Figure 13 pictures the most recent additions, types A and B de-ions arresters for distribution apparatus protection. On these new arresters the impulse discharge voltage is considerably lower than that commonly associated with protector

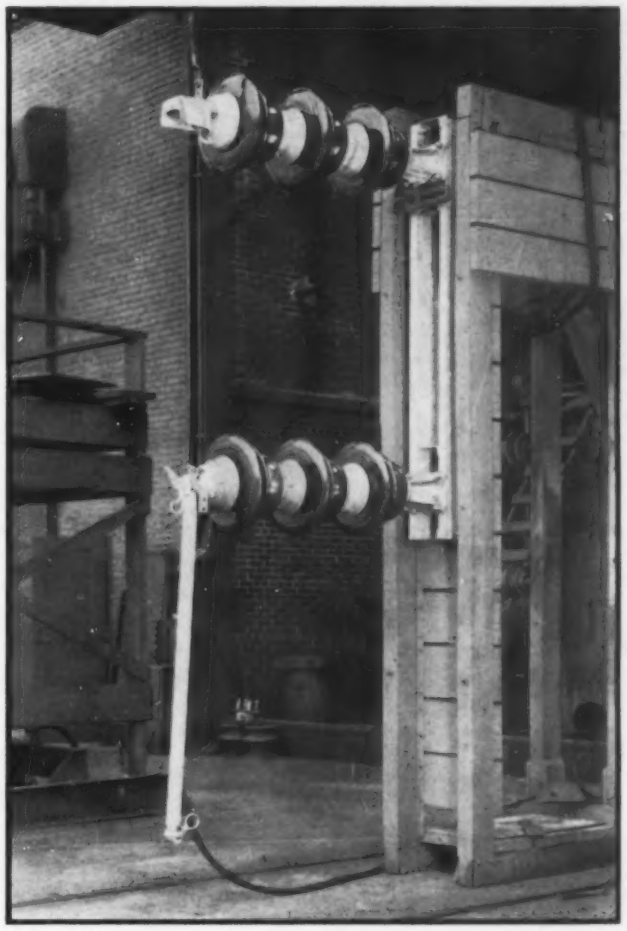


**Figure 11 — Fuse, 115 kv, in dropped-out position after blowing.**

tubes, while at the same time they are capable of handling a considerable proportion of the direct lightning strokes that our field studies show are liable to occur. Their action is current-limiting.

## POWER CAPACITORS

Under pressure of war time activity and restrictions, many new applications of power capacitors have been made. Installations of outdoor capacitors to replace synchronous condensers have been found more economical than the synchronous condensers. Power capacitors have been used for starting large motors on long lines which otherwise could not have been done without prohibitive increase in cost of the lines. The new sprayed zinc finish used on outdoor capacitors permits permanent installation outdoors. Developments in capacitors for the electronic field have resulted in many improvements that will be incorporated in a-c power capacitors for postwar use.

## GENERATOR VOLTAGE REGULATORS

In the generator voltage regulator field, new developments in rotating amplifiers such as the Rototrol provide interesting possibilities. It is still necessary to have a suitable element control head which in turn controls the action of the rotating amplifier. This control head may be of the electro-mechanical type, electronic, or a combination circuit comprising reactors, capacitors, and resistors.

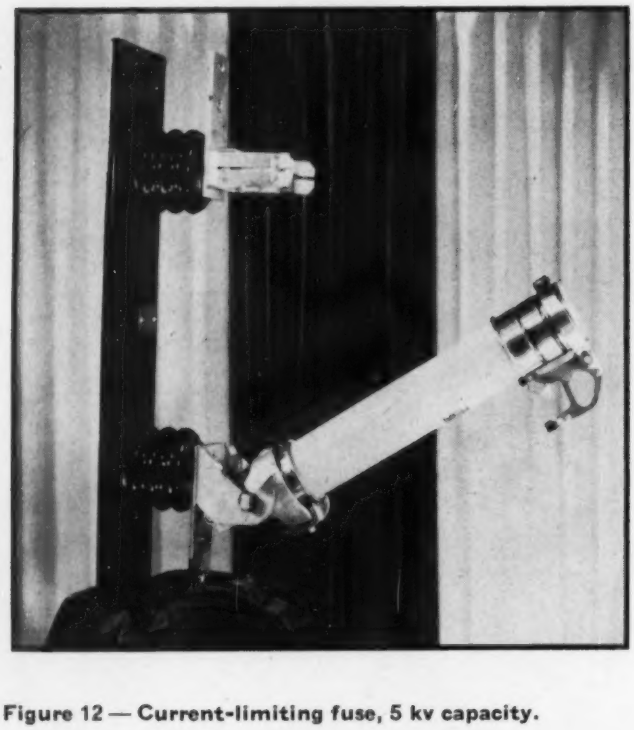
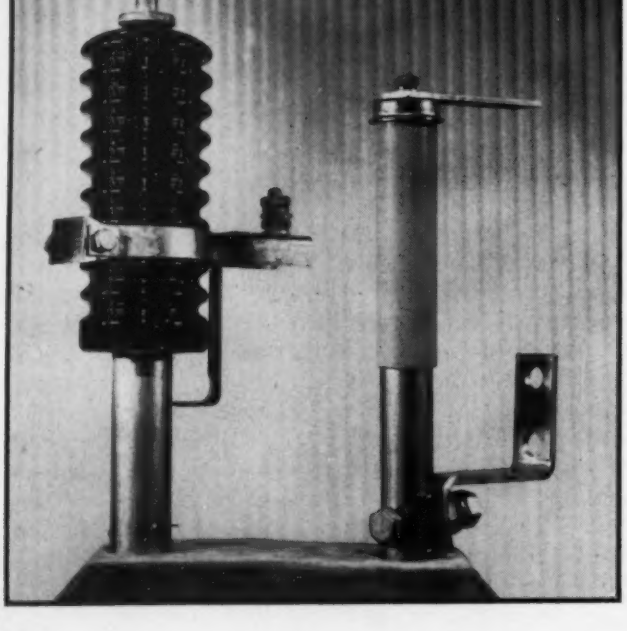


**Figure 12 — Current-limiting fuse, 5 kv capacity.**

▲

**Figure 13 — Lightning arresters, standard type A (left) and type B, both 6000 volts.**



The Rototrol and similar units are essentially d-c generators having characteristics which give them the ability to "amplify," that is, to produce quickly a large output as a result of a change in a relatively small input to its field. Such units are familiar for speed and tension control for mills, and for electrode control in arc furnaces. For voltage regulation where indirect acting rheostatic regulators have been used, the rotating unit would eliminate the motor operated rheostat and its contactor panel. Whether this system will supersede the present simple direct-acting regulator on any but the larger generators is not yet clear. Present applications are limited to auxiliary generators on Naval vessels.

Electronic regulators are being used for those voltage regulator applications where special precision or unusually fast response is required. The field of application in industry is broadening, however, as a result of improvements in excitation systems, and is being continuously studied. Either power rectifiers or rotating exciters are well suited for use with electronic regulators for high speed response. It should be noted, however, that the time delay within a good electro-mechanical regulator is a relatively small part of the time delay inherent in the machine fields. For this reason an electronic regulator can improve voltage dip and total recovery time by only a few cycles, compared with the corresponding time required by an electro-mechanical regulator.

The greatest advantages of electronic regulation are obtained where a rotating exciter of special design is used, or where a rectifier is used in place of the rotating exciter to supply directly the field of the a-c generator. Such an application might be a high frequency generator for an induction furnace for heat treating, which requires very fast response.

## POWER LINE CARRIER CURRENT

The use of power line carrier channels for line relaying, telemetering, telephone communication and supervisory control has increased greatly as a result of satisfactory experience and the general development of electronic apparatus. The overall applications are usually coordinated, resulting in the common use of a single channel for several of these purposes. Also the use of tone modulation has made carrier more attractive, since this increases the number of channels available with a small amount of additional equipment.

The general trend of the industry is reflected in the fact that supervisory control by carrier rather than by wire is now being requested in about fifty per cent of our negotiations. In passing, it might be noted that the Geneva steel mill is equipped with supervisory control on all main substation breakers. This control is by wire, however, not carrier.

There are many more developments in switchgear activity, some of which are, of course, still on the secret list. However, it is hoped that this discussion has given some idea of the wartime progress in switchgear engineering and the plans under way to take care of the industry in the period of peace which we all hope is ahead.

# DISCUSSION

PRESENTED BY

H. A. P. LANGSTAFF, Electrical Engineer, West Penn Power Company, Pittsburgh, Pennsylvania

F. E. FAIRMAN, JR., Assistant Manager, Switchgear Division, General Electric Company, Philadelphia, Pennsylvania

J. W. STIRLING, Manager, Protective Devices Section, Switchboard Application Department, Westinghouse Electric Corporation, East Pittsburgh, Pennsylvania

C. O. FRANKLIN, Electrical Engineer, Carnegie-Illinois Steel Corporation, Munhall, Pennsylvania

M. H. HOBBS, Manager of Engineering, Switchgear and Control Division, Westinghouse Electric Corporation, East Pittsburgh, Pennsylvania

**H. A. P. Langstaff:** Our manufacturers are to be congratulated for the developments they have made during the war period. To make these developments with the man shortage has been a difficult task but I believe they have done exceptionally well. I happen to have been one of those favored in the witnessing of the tests made at East Pittsburgh as mentioned by Mr. Hobbs and as the tests progressed one could not help but compare the breaker performance with that with which we had to contend only a few years ago. During tests made at Wilmerding Substation of Duquesne Light Company I originated the phrase that "A breaker should have a standby rating," meaning that an operator should be able to stand near a breaker functioning in accordance with its rating. The recent tests prove that this requirement is possible with present-day switchgear.

This statement applies not only to outdoor but also to indoor switchgear, in which great improvements have been made. There still remain a few difficulties from a safety point of view which need to be rectified and it is possible that many have already been made. The metal-clad switchgear today is much safer than most other designs.

We are in the midst of transition from a certain type of outdoor switchgear for 25 kv circuits which only a few years ago we would never have thought possible. We are considering cubicle switchgear units with 34.5 kv rating for use on our 25 kv circuits, thereby eliminating the present more or less universal type of high outdoor open wiring designs which are not easy to maintain and paint, and cannot be considered pleasing in appearance.

**F. E. Fairman, Jr.:** Mr. Hobbs is to be congratulated on the forward-looking paper. If anything, he has been over-conservative in his appraisal of the magnitude of the contribution that the switchgear industry has made during the last few years and has played down the very real difficulties under which switchgear engineers have continued developmental work.

To briefly present just one representative difficulty peculiar to these times through which we are passing, I want to cite the major problem existing today in so simple a matter as the procurement of tools. By this word "tools," I do not mean snow shovels or the variety of other small implements known as tools by the layman. I refer to the manufacturing implements on the availability of which depends "tool-made production" of a piece of switchgear as opposed to the hand-made initial developmental sample. After you have a hand-made sample for test, after tests and minor changes are complete, after all manufacturing drawings are prepared including the changes found to be necessary in the course of tests, to obtain tools to put such an item in regular production is almost an equally difficult problem to all that has gone before. Frankly, it is all but impossible either to get such tools built inside your own organization or to obtain them through any outside source.

Due to the many problems of which the single cited difficulty is only one, during the war program of the last three or four years it has been a tough job to get actual combat requirements into production, let alone all the new, more effective apparatus for general use which the manufacturers would like to produce.

When we look at the broad range of progress in switchgear that has taken place over the last ten years, it is only fair to recall that the steel industry was among the first to see the advantage of complete coordinated equipment built with recognition of the actual requirements of the job.

This forward-looking action on the part of the steel industry has been a great help to all switchgear manufacturers in advancing intelligent design progress. The tremendous sustained production peak that steel has contributed to the war effort is both a tribute to soundness of the applied switchgear designs and to the perspective of the progressive steel mill engineers responsible for so equipping their production facilities to meet such emergencies.

I wish heartily to endorse Mr. Hobbs' comment with respect to the prevalent trend toward air circuit breaker applications. For 6600 volts (a well-known voltage in steel mills), in fact for voltages up to 15 kv with stabilized neutral, the use of metal-clad switchgear has been a mill standard over the last ten years. Today that same fundamental design with self-contained magnetic blowout air circuit breakers is rapidly superseding oil circuit breaker applications. In fact, today when we receive such an order for equipment with oil circuit breakers, we generally try to substitute the air circuit breaker unless it is a very special order for one or two circuits to extend an existing metal-clad structure already equipped with oil circuit breakers. Even in cases of this special kind we try to review the situation carefully to see whether there is any chance to give the user the benefit of the more modern interrupter.

Mr. Hobbs' comments on the high-voltage breaker development are very timely and represent the vast progress that has been made over the last little while. In that field also, the trend is distinctly toward higher speeds, and with those higher speeds, better breaker performance and a more proficient use of materials and content of the breaker. At voltages of 115 kv and higher, 3-cycle operation is available, and very high reclosing speeds.

The high-speed camera is a tool which we feel will be of increasing significance to designers of all types of apparatus, but particularly to designers in the switchgear field. It was a decided shock to see the high-speed films of our Navy shock tests on low voltage air circuit

breakers. In particular, the three-phase breakers which looked as sturdy as the Rock of Gibralter seemed to make any notion of mechanical distortion an absurdly unlikely result. The revelation came when the initial designs were seen via the high-speed film with the various apparently rigid parts weaving around flexibly with respect to each other. Entirely apart from the Navy shock program standpoint, the high-speed camera obviously is a valuable tool for the designer of the future and the study of mechanism and mechanical performance in general.

**J. W. Stirling:** There is one point that Mr. Hobbs mentioned on which further development might be interesting. That is the lightning arrester which he mentioned. Everyone is conscious of the necessity of protecting rotating equipment from damage by lightning, and the development of the de-ion arrester definitely contributes to that protection.

Most systems have in some way or another a piece of rotating apparatus connected to an exposed line, possibly through a transformer or through a section of cable. All of those conditions, of course, enter into the selection of the equipment for the protection of the machine.

Considering generally the rotating machine connected directly to a line, the problem of protection is to limit the voltage at the terminals of the machine to a very low value; this has been done by applying the conventional valve type arrester. The problem in very steep surges is to limit the rate of rise of the surge so as to limit the voltage from winding to winding; therefore a capacitor is also connected at the terminals of the machine. But from there on the problem of protection changes with the use of the de-ion arrester. By applying the de-ion arrester of the discharge type out on the line, the amount of energy that can come to the terminals of the machine is limited, because the arcing characteristic limits not only the sparkover voltage but also the voltage across the arrester during the discharge period, and regardless of the amount of surge current or the amount of power follow current through the arrester, the amount of energy that comes into the machine is definitely limited. In that manner, the de-ion expulsion type arrester is definitely contributing to better operation and performance of rotating apparatus.

**C. O. Franklin:** I was very much interested in the fuse that Mr. Hobbs described. Am I right in saying that it is capable of interrupting 60,000 amperes at 5,000 volts?

**M. H. Hobbs:** It doesn't interrupt a current of 60,000 amperes, because it is a current-limiting fuse, but it will interrupt a 60,000 ampere circuit, that is, a circuit which would be capable of delivering 60,000 amperes if the fuse were not there.

It should be noted, however, that the fuse must be applied on the basis of the momentary current which the circuit will deliver. This is approximately 1.6 times that demanded of a circuit breaker in the corresponding circuit, because the breaker requires a longer time to interrupt, during which, due to the decrement, the current will die down to a certain extent. Putting it another way, a circuit requiring a 100,000 kva breaker would require a 160,000 kva capacity fuse.

**C. O. Franklin:** Would it be capable of protecting a transformer on a system of very large capacity that would require, say 500,000 kva breakers?

**M. H. Hobbs:** Up to its capacity, that is right.

**F. E. Fairman, Jr.:** I would like to say a word on the current-limiting fuse. For sometime past in publishing ratings on such fuses, we have striven to coordinate them so that they will be understandable in power circuit breaker terms. For example, in a large steel mill system there might be 2300 volt "islands" consisting of relatively small motor circuits suitable for that voltage (as opposed to the main 6600 volt system voltage) and falling within the applicable scope of starting equipment employing the current-limiting fuse as a fault interrupter. The maximum power circuit breaker intelligently applicable at 2300 volts is the 1200 ampere, 150,000 kva, 5 kv breaker. Such a breaker has a published interrupting rating of 37,500 amperes at 2300 volts. However, in making an application to utilize such interrupting capacity, the breaker would require an initial momentary rating of 60,000 amperes, which happens to be the published momentary rating for that particular breaker. A moment's consideration of commonly encountered actual short circuit decrement conditions will confirm this picture, because some interval of time must elapse between the inception of the fault and the instant when the breaker contacts part; therefore, the fault must have come down from some initial peak value of current, which in the case cited would probably lie somewhere between 50,000 and 60,000 amperes.

The current-limiting fuse operates so rapidly in interrupting a fault that required actual fuse interrupting ratings in amperes must associate themselves, in an engineering sense, with the conditions described above that necessitate the published momentary ratings for power circuit breakers. In order to put all these ratings on a common basis for convenience in readily deciding correct applications, the current-limiting fuses have published ratings in terms of the three-phase kva interrupting ratings associated with NEMA standard power circuit breakers.

There is one further pertinent comment regarding fuses of this type. They are applicable to 60-cycle systems. The smaller continuous ratings, say up to a published continuous rating of 10 amperes maximum, are also applicable on 25-cycle systems for the protection of such items as potential transformers and small control power transformers. It may be that sometime in the future it will be possible to design such fuses in excess of 10 amperes for application on 25-cycle systems, but the field has not been covered at 25 cycles so far as the necessary background of tests and other developmental information is concerned.

**C. O. Franklin:** Is this the 60 cycle rating, and how much is it decreased for 25 cycles? I know that for some fuses they give a certain rating for 60 cycles, and decrease it 40 per cent for 25 cycles. I just wondered if that is the case with this fuse.

**M. H. Hobbs:** The rating for fuses is usually different, and usually lower for 25 cycles than for 60 cycles. This new current-limiting power fuse is still in the course of development, and, although some interrupting tests at 25 cycles have been made, these are not sufficient to enable us to fix the 25 cycle rating. We expect to be able to do this in the near future.

# Symposium-

# DISPOSITION OF COKE OVEN GAS AND BLAST FURNACE GAS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## ....at Warren Plant

### REPUBLIC STEEL CORPORATION

*by* **PAUL E. LEISS**

▲ THE disposition of coke oven and blast furnace gas in a steel plant is largely an individual problem, depending on very many factors. What may be ideal in one plant may not be the right method in another plant. The many changes and problems in the Warren District of Republic Steel Corporation and how they were worked out are described in this discussion.

In a general way the products normally made at this plant are flat rolled products — tin plate, hot rolled strip and sheets, including such commodities as hot rolled stainless and silicon strip coils and flats. With this type of product, equipment using fuel (such as annealing and normalizing furnaces) are more numerous that in some other plants. Our finishing mill capacity is considerably in excess of pig iron- and steel-making capacity. This means that many tons of steel from other plants, in either ingot, slab, or billet form are processed in this piant, which means that our coke oven and blast furnace gas available is not sufficient to supply all our needs.

Our blast furnace gas is so valuable for electric power generation, keeping down the demand charges, that it is not economically sound to divert but small quantities of this gas for metallurgical furnaces.

During depression days, with rather low coke plant operations, we used large quantities of natural gas. In order to reduce this more expensive fuel we installed


Presented before A. I. S. E. ANNUAL CONVENTION, Pittsburgh, Pa., Sept. 25-27, 1944

facilities for mixing blast furnace and coke oven gas only to the capacity of the existing coke oven gas boosters and to the limit of our existing supply mains and branch lines. With increased operations however, we found that a mixture of coke oven gas with up to 10 per cent of blast furnace gas worked out very well. Contrary to what might be expected from a theoretical standpoint, it did not make much difference on lower temperature furnaces whether we used straight coke oven gas or coke gas with about 10 per cent blast furnace gas mixed in. At this time coke oven gas was being used almost exclusively on such consumers as annealing and the old type hot tin mill furnaces. The results showed a considerable reduction in natural gas consumption. As an average the actual results showed that one volume of natural gas was replaced with three volumes of blast furnace gas. Above 10 per cent blast furnace gas in the mix we gained nothing. We lost production. On higher temperature furnaces, such as slab- and billet-heating furnaces, the effect of mixing any blast furnace gas was very noticeable, in that we made no gain in overall fuel cost or consumption and lost production.

In the normal week-day operation of the plant, fluctuations in the total gas demand will vary 25 per cent above or below the average. To overcome some of this variation, we simply used blast furnace gas in the mix in varying quantities as described above. However, with the desirability of elimination of some of the producer gas to get higher tonnage production, our natural gas demands increased considerably and we installed a gas-mixing station, wherein natural gas and air mixture was used to make up a shortage of coke oven gas. This also served as a balancing station where excess coke oven gas was utilized without changing our burners or fuel air ratio controls. As it happened we had one group of furnaces, which would use up to 100 per cent of our total coke gas supply at peak operating conditions. This mixing station was installed solely in connection with this one group of furnaces. This station was entirely automatic and required no regular attendant except to keep the controls in order and maintain the other equipment. The proper safety controls were of course included. Figure 1 shows this arrangement.

This station was installed in 1937. In about 1940 natural gas was no longer available at all times and we had to resort to fuel oil on these particular furnaces. The furnaces were triple-fired slab-heating furnaces so that we could, of course, use oil or gas on any of the rear zones of the furnaces and change from one to the other manually. However, we are so equipped that we can use gas or oil simultaneously, and so arranged that any available coke gas will automatically cut in this quantity of gas and reduce the oil and vice versa.

In 1942 it was decided to install an additional battery of coke ovens at Warren. Previous to this time we had used gas which was not thoroughly cleaned and was not desulphurized, containing sulphur up to 500 grains per 100 cubic feet. With the additional gas from another battery we had to use coke oven gas for such use as stainless heating, normalizing, etc., where a clean desulphurized gas was necessary. For this purpose, we installed electrical precipitators and desulphurizers which gave us a gas with sulphur content of 40-50 grains of sulphur per 100 cubic feet. We also installed additional coke gas lines because existing lines were too small and to take advantage of the lower sulphur con-

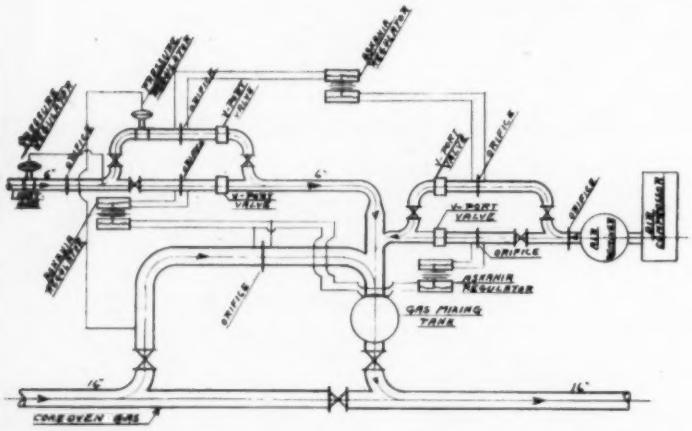
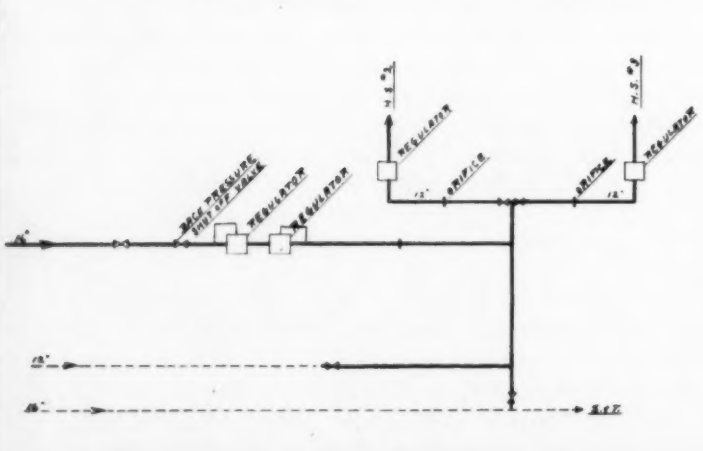
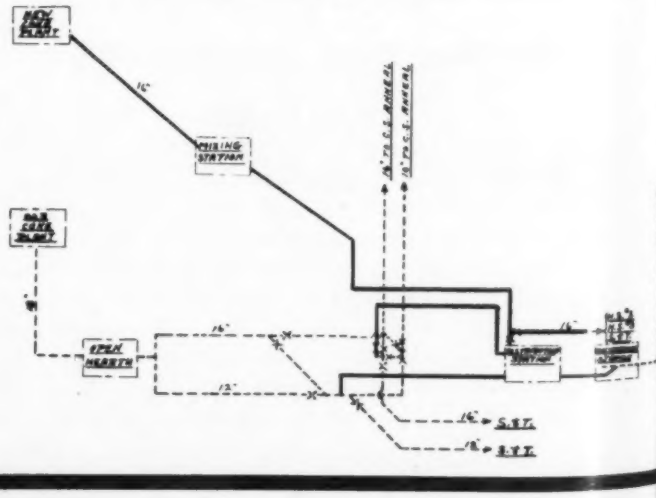



**Figure 1 — Sketch showing arrangement of station mixing natural gas and air to supplement coke oven gas supply.**

**Figure 2 — Sketches showing the old (bottom left) and new (bottom right) arrangements of coke oven gas system.**



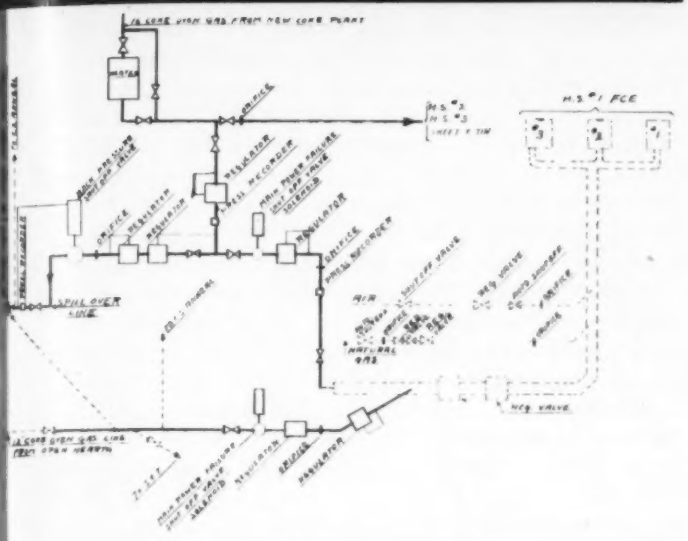


**Figure 3 — Sketch of arrangement made to take care of coke oven gas which is returned from sponge iron plant.**

tent gas at such points where it might be used advantageously. Figure 2 shows the old and new arrangements. In this sketch it will be noted that at our older coke batteries we had a 5 psi gas booster, while at the new battery we had 10 psi booster, so that the problem was to keep the clean gas separate from the uncleaned gas.

Shortly after this arrangement was all worked out and while it was still being installed, it was decided to install an experimental ore reduction plant, generally called a sponge iron plant. The basis of this ore reduction plant is the reduction of ore by means of hydrogen in the coke oven gas. This brought up some very interesting problems and to some extent complicated the gas system and something different had to be done. In the ore reduction arrangements and plans, it is evident that we would lose about 20 per cent of the hydrogen in the coke gas, and since the gas for reduction purposes will be preheated at temperatures ranging from 1150 F to 1500 F, the question was whether or not, aside from the loss of hydrogen, we would also not break up the heavy hydrocarbons and possibly some methane. We might get gas of a higher Btu content, or a lower Btu content, or the same Btu content but in any case of different composition, which undoubtedly would make considerable difference in furnace flame characteristics. To overcome and handle whatever might come up and not interfere with our mill productions and heating operations, it was either a case of correcting at individual furnaces or providing a central point to restore the original characteristics. Without knowing what might occur, it was decided to provide another mixing station and take care of this at a central point. Figure 3 shows how we will endeavor to cover the conditions. In this arrangement it will be noted that we are in a position to either dilute the gas with some air, or enrich it with some natural gas, or both. In part of this it will also be noted how we will cover loss of gas volume and take advantage of the lowest pumping cost.

From this history of the use and handling of coke oven gas, it will be apparent that we have probably had a wider variety of conditions to meet than usual. We have never had anyone assigned to the distribution and handling of coke oven gas or mixing stations, except for maintenance of control instruments or other equipment. We have little chance of bleeding coke oven gas except on week ends, when by watching mill schedules, we also schedule a certain volume to our boiler houses. We bleed little gas at any time except under unusual conditions, such as major shutdowns.

During the evolution of our gas handling arrangement as described, we learned or unlearned many things about heating operations which has shaken our confidence in what we had previously thought we knew. We have come to the conclusion that there is still much to be learned about heating and that heating is still somewhat of an art and not yet an exact science.

Among the unexplained things we have learned which are not thoroughly understood, we find that on slab- or billet-heating furnaces, with a total heat input of coke oven gas and the same Btu input of mixed natural gas and air, the same production and heating will be obtained with equal Btu consumption per ton. However, with a mixture of approximately equal parts of coke oven gas and mixed natural gas and air, and the same total Btu input as with either fuel alone, our production and heating is better and the fuel consumption per ton is better.

Some simple method of determining the heating effect of gases would be of great value.

## . . . . at Johnstown Plant

### BETHLEHEM STEEL COMPANY

By HAROLD C. COX

▲ THE problem of disposing coke oven and blast furnace gas over week-ends became of prime importance at the Johnstown plant of Bethlehem Steel Company about fifteen years ago. At that time the subject was given serious consideration in order to improve plant costs.

At the present time, however, proper disposition of all coke oven and blast furnace gas produced is not only important from the economic point of view, but it is a patriotic duty to see that every cubic foot of these gases is used to save other fuels for the war program, and to conserve our country's natural resources.

In disposing of the two gases, our object has always been to displace other fuels, such as oil and coal. Oil has to be shipped into Johnstown and is our most expensive fuel, while coal, mined inside the plant, is not so expensive.

The handling of coke oven gas and blast furnace gas in the Johnstown plant is rather simple, but in order to explain the methods used, the two gases will be considered singly, and in the order named.

The plant does not have a coke oven gas holder and

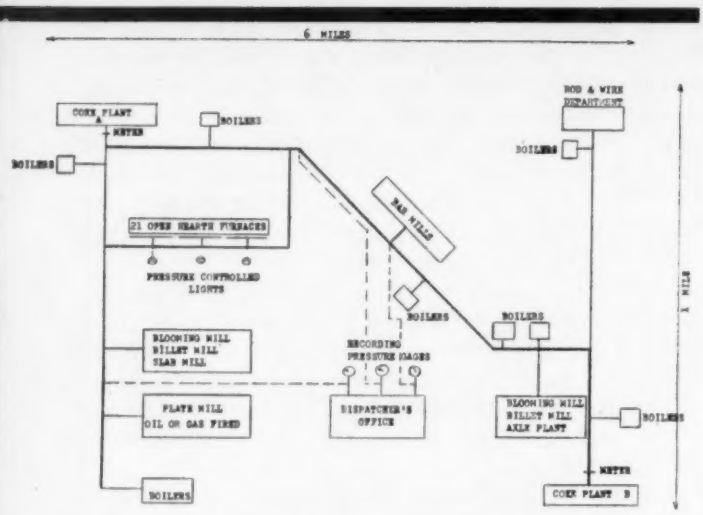



**Figure 1 — Schematic layout of coke oven gas distribution system at Johnstown plant of Bethlehem Steel Company.**

the disposition of surplus gas from the ovens is therefore based on using the gas as fast as it is produced. Figure 1 shows a diagrammatic layout of the coke oven gas system. Two coke plants, about six miles apart, pump gas at 150 in. water pressure into the mill trunk lines. The 150 in. pressure gradually decreases along the pipe lines and generally reaches a low point at about the center of the system, near the bar mills. In order to keep all the bar mills supplied with gas, the pressure must not be permitted to fall below 35 in. at the lowest point, and to keep the coke plants from wasting gas, the pressure must not be allowed to go over 150 in. The problem of disposing of the gas thus resolves itself into one of pressure regulation.

The first step in regulating the gas pressure is taken in the open hearth department. Twenty-one open hearth furnaces have been divided into three groups and electric control lights have been installed on each furnace instrument panel. These lights are colored red and, if they are burning, the furnace operators must not use gas because the pressure is too low. However, when the pressure in the gas main rises to 45 in., the lights in one section of the open hearth go out and seven furnaces may use gas and cut back on the liquid fuel. If the pressure continues to rise the second group of lights go out at 50 in. and so on, until at 60 in. pressure all the lights go out and all the open hearth furnaces may use gas. If the pressure begins to fall in the gas main the lights go on in the reverse order and the furnaces cut off gas and add liquid fuel to make up the difference.

The open hearth signal light system works automatically according to the gas pressure, but the decision to use gas when it is available rests with the furnace first helper. It may not be convenient for a furnace to take gas due to the heat conditions, but generally speaking the open hearth department can be counted on to take 150,000 cu ft of coke oven gas per hr per section, or 450,000 cu ft per hr in the entire department if all the red lights go out.

When the open hearth can not take care of the

**TABLE I**

**SCHEDULE OF MILL OPERATIONS FOR ONE WEEK SHOWING M CU FT OF COKE OVEN GAS PER HOUR**

| M cu ft per hour | Department | Saturday | | | Sunday | | | Monday | | | Tuesday | | | Wednesday | | | Thursday | | | Friday | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | D | M | N | D | M | N | D | M | N | D | M | N | D | M | N | D | M | N | D | M | N |
| 35 | Ladle house L.W. | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 |
| 35 | Ladle house Fkln. | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 |
| 125 | Steel car shop | 125 | 75 | | | | 25 | 125 | 75 | 25 | 125 | 75 | 25 | 125 | 75 | 25 | 125 | 75 | 25 | 125 | 75 | 25 |
| 50 | F.O.H. misc. | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 |
| 150 | 40 in. bloom mill | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 | Rep | airs | 150 | 150 | 150 | 150 | 150 | 150 | 150 |
| 100 | 34 in. slab mill | 100 | 100 | 100 | | 50 | 50 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 150 | 134 in. plate mill | | 150 | 150 | | 150 | 150 | | | | Use | gas o | r oil | bala | nce | of w | eek | — 3 | turn | oper | ation | |
| 30 | 12 in. mill | | | | | | 15 | 30 | 30 | 15 | 30 | 30 | 15 | 30 | 30 | 15 | 30 | 30 | 15 | 30 | 30 | 15 |
| 15 | 9 in. — 1 mill | 15 | | | | | 10 | 15 | | 10 | 15 | | 10 | 15 | | 10 | 15 | | 10 | 15 | | 10 |
| 15 | 8 in. — 1 mill | 15 | 15 | 15 | | | 10 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 |
| 35 | Rake shop | 35 | 35 | 35 | | | 15 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 |
| 120 | 36 in. universal mill | 120 | 120 | 120 | | | 60 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 |
| 50 | 9 in. — 2 mill | 50 | 50 | 50 | | | 25 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 |
| 30 | 9 in. — 3 mill | 30 | 30 | 30 | | | 15 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 |
| 85 | 10 in. mill | 85 | 85 | 85 | | | 50 | 85 | 85 | 85 | 85 | 85 | 85 | 85 | 85 | 85 | 85 | 85 | 85 | 85 | 85 | 85 |
| 100 | 13 in. mill | 100 | 100 | 100 | | | 50 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 120 | 14 in. mill | 120 | 120 | 120 | | | 60 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 | 120 |
| 150 | 48 in. bloom mill | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 50 | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 |
| 20 | Bessemer | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 |
| 25 | Axle plt. forge | 25 | 25 | 25 | | | 15 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 |
| 60 | Axle plt. mill | 60 | 60 | | | | 45 | 60 | 60 | 45 | 60 | 60 | 45 | 60 | 60 | 45 | 60 | 60 | 45 | 60 | 60 | 45 |
| 30 | Mechanical shops | 30 | 20 | 20 | | | 10 | 30 | 20 | 20 | 30 | 20 | 20 | 30 | 20 | 20 | 30 | 20 | 20 | 30 | 20 | 20 |
| 60 | Rod mill | 60 | 60 | 60 | | | 30 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 60 |
| 10 | Pots | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 1 0 | 10 | 10 |
| 5 | Bakers | 5 | 5 | | | | | 5 | 5 | | 5 | 5 | | 5 | 5 | | 5 | 5 | | 5 | 5 | |
| 10 | Galv. R and W | 10 | 10 | 10 | | | 5 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| 10 | Beth. R and W | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| Total demand | | 1445 | 1520 | 1380 | 460 | 660 | 1100 | 1475 | 1400 | 1325 | 1375 | 1400 | 1325 | 1325 | 1250 | 1325 | 1475 | 1400 | 1325 | 1475 | 1400 | 1325 |
| Total gas from coke | | 1550 | 1550 | 1550 | 1550 | 1550 | 1550 | 1550 | 1550 | 1550 | 1550 | 1550 | 1550 | 1550 | 1550 | 1550 | 1550 | 1550 | 1550 | 1550 | 1550 | 1550 |
| Surplus | | 105 | 30 | 170 | 1090 | 890 | 450 | 75 | 150 | 225 | 175 | 150 | 225 | 225 | 300 | 225 | 75 | 150 | 225 | 75 | 150 | 225 |
| Short | | | | | | | | | | | | | | | | | | | | | | |

changes in gas pressure, the gas dispatchers must take a hand in the situation. There is a dispatcher's office in the plant, with two men on duty on each eight hour turn. These men, in addition to dispatching coke oven gas, operate a blast furnace gas cleaning plant consisting of towers and disintegrators, and they also dispatch blast furnace gas to several departments. In the dispatcher's office are recording gages which show the coke oven gas pressure in different parts of the plant. These gages are of the telemetering type. If the pressure gets too high near coke plant A, the dispatcher calls the plate mill and has the furnace operators change from liquid fuel to gas. The plate mill has seven slab heating furnaces which, in a few moments, can be changed one at a time from liquid fuel to gas or from gas to liquid fuel, according to instructions from the gas dispatcher. Altogether these seven furnaces can use 150,000 cu ft of coke oven gas per hr.

If the pressure in the gas mains continues high after the open hearth and plate mill furnaces are switched to gas, the dispatcher will call the boilerhouses, of which there are eight located throughout the plant, and have them use gas. He can have all the boilerhouses use gas under all the boilers, or he can have only some of the boilers use gas, just as he sees fit. Solid fuels burned on grates under the boilers are reduced when gas is used. The boilers can use up to 500,000-600,000 cu ft of coke oven gas per hr.

In case the gas pressure in the mains begins to drop, the dispatcher reverses the procedure and cuts gas off all boilers first, and then off the plate mill furnaces. The open hearth furnaces will of course get off automatically when the red lights go on.

In order to help dispatch the gas, a weekly schedule of mill operations is made up each Friday. A copy of a typical schedule is shown in Table I. This schedule shows the gas requirements of the various departments, along with the gas output of the coke plants. At a glance the dispatchers can tell the surplus of gas they should have on hand and can govern their dispatching of the gas accordingly. It is readily seen how the surplus grows on weekends, and how much gas must be burned in the open hearths and under boilers over Saturdays and Sundays to prevent wastage.

By the above methods the coke oven gas requirements of the mills have been met satisfactorily in the past years, and the wastage has been kept to one per cent, or less, of the total quantity produced.

There are only a few users of blast furnace gas, including stoves, boilers, a coke oven battery and soaking pits, and since these units operate continuously seven days a week, the problem of dispatching the gas resolves itself into one of handling the gas only when furnace stops or irregularities occur. At Johnstown the boilers take all swings, substituting liquid or solid fuel for blast furnace gas as the need may arise. The dispatcher is informed by the blast furnace operators of all furnace casts, stops, wind changes and stove changes, and he in turn keeps the boiler operators informed about the amount of gas available for them. The pressure in the blast furnace gas system is maintained at 10 to 25 in. of water. Alarms tied into the gas mains sound loud warnings when the pressure goes below or above the limits set, and the dispatchers and boiler operators immediately make corrections accordingly.

Based on 70 cu ft of gas per pound of coke charged into the furnaces, the consumption of blast furnace gas at the Johnstown plant shows a yield of 83 per cent; in other words, 17 per cent is unaccounted for or wasted.

In conclusion, it might be stated that scheduling of the mills has been tried with some operating on weekends and shutting down a day or so during the week, but it seems that of all the days the men may take off, they like the one between Saturday and Monday the best. A balanced schedule of mills over the seven days of the week would undoubtedly save more oil.

Finally, nearly every steel plant could increase its use of coke oven gas by using a large gas holder, of about 6,000,000 cu ft capacity. This, we realize, would be costly, but the time has come when such cost might well be justified.

## . . . . at Clairton Works

### CARNEGIE-ILLINOIS STEEL CORPORATION

*by R. A. LYTLE*

▲ IN the manufacture of metallurgical coke from coal in by-product coke ovens, approximately 10,000 cu ft of gas is produced per ton of coal carbonized. Generally speaking, most by-product plants are operated for the production of blast furnace coke, and in most instances coke demands often dictate the rate at which the by-product plant is to be operated. However, since the advantages of the process are realized from the values of the additional products recovered, it is only obvious that an outlet for the continuous use of gas must be available in order to preserve continuity of by-product recovery and at the same time avoid wastage of the various supplemental fuels produced by the process.

The Clairton by-product coke works of Carnegie-Illinois Steel Corporation carbonizes about 30,000 net tons of coal per day, thus producing 300 million cubic feet of coke oven gas. The gas has an average calorific value of 560 Btu per cubic foot and a specific gravity of 0.38 at standard conditions. The disposition of this gas and the products recovered from it will be discussed to show the method of continuously maintaining the proper balance in supply and use of the gas.

The gas produced in the ovens contains various by-products and to permit maximum economy in the process, it is necessary to remove these by passing the gas through equipment to accomplish their recovery. To accomplish this the gas is drawn by exhausters into a system of collecting mains, in which, at reduced pressure, its temperature is lowered and part of the tar removed by spraying with weak ammoniacal liquor. The higher boiling point tar vapors are condensed and the flow of liquor keeps the suction system free of pitch

deposits. By draining the flushing system into a number of decanters, the weak ammonia liquor is partially separated from the tar and part of the weak ammonia liquor pumped back into the gas main to be used in flushing. Surplus liquor is processed for the recovery of ammonia. From the collecting mains the gas is drawn through primary coolers in which most of the remaining tar and condensible vapors are removed and in which the gas is cooled to a temperature at which it can be handled by the exhausters. These exhausters deliver the gas at a pressure of 2 psi. The tar recovered from all sources at the rate of 10½ gallons per ton of coal is pumped to the tar plant where a portion of it is processed for the recovery of tar acids, creosote, napthalene and fuel tar.

The discharge pressure of the exhausters is sufficient to force the gas through the by-product and benzol scrubbing equipment and to maintain the required pressure of gas for the oven heating system. The by-product equipment consists essentially of tar extractors to remove the last traces of tar and the necessary equipment for recovering the free ammonia in the gas and that recovered by steam distillation from the weak liquor, using sulphuric acid to form ammonium sulphate. Ammonium sulphate is produced at the rate of 23 to 25 pounds per net ton of coal. It is necessary to cool the gas to 30 C in the final coolers in order to obtain maximum absorption of benzol and its homologues in the wash oil scrubbers. A light oil is recovered from the benzolized wash oil at the rate of three or more gallons per ton of coal and is subsequently refined into various grades of benzol, toluol, xylol, solvents and residues. After the gas has passed through the scrubbers, it is ready for distribution as a fuel gas.

The gas pressure of 15 in. of water column required for the oven heating system is supplied by the exhausters and controlled by maintaining the height of a gas holder, which is directly connected to this low pressure gas distribution system. The height of the holder is maintained at a predetermined level by increasing or decreasing the amount of surplus gas drawn from this system by the turbo boosters. The gas holder serves to minimize small momentary fluctuations in gas flow and, in case of emergency, acts as a safety valve by causing the bleeder valves to open at the extreme upper travel of the holder. Thus, while gas is not wasted through the bleeders under normal operations, they are capable of bleeding sufficient gas for plant protection in case of an emergency.

Approximately 40 per cent of the total gas produced or 120,000,000 cu ft per day is returned to the ovens for oven heating. The surplus of 180,000,000 cu ft per day is delivered by the low pressure distribution system to the booster station, where, through two-stage compression, the pressure is increased to 15 psi to supply the consumers on the high pressure distribution system. Thus, a very high grade fuel is delivered directly to the furnaces, ready for use without additional preparation at the equivalent rate of 4,000 net tons of coal per day. This high pressure distribution system consists of 32 miles of pipe line varying in diameter from 20 to 48 in. in this system. Straight coke oven gas is delivered to two steel plants and a mixture of coke oven and natural gas is supplied to four additional major steel plants. Three additional consumers, namely two boiler houses and a gas compressor station, are used to balance the demand with the supply and to some extent the latter might be considered to temporarily influence the supply.

Straight coke oven gas is delivered to the Clairton steel works at the average rate of 25,000,000 cu ft per day, where 60 per cent is used for basic open hearth melting fuel, 10 per cent for soaking pit fuel, and 30 per cent for the reheating furnaces on three light structural shape mills and one bar mill. The Irvin works of the Carnegie-Illinois Steel Corporation is also supplied with

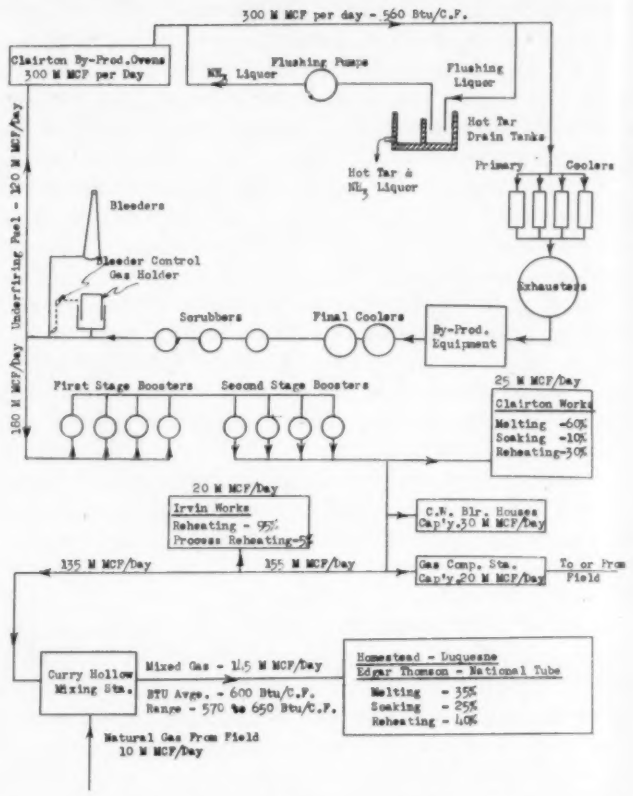



**Figure 1 — Chart showing disposition of coke oven gas at Clairton works, Carnegie-Illinois Steel Corporation.**

20,000,000 cu ft per day of straight coke oven gas, of which 95 per cent is used for reheating in slab and annealing furnaces and 5 per cent as an auxiliary fuel under boilers. Thus, after supplying the straight coke oven gas consumers, there is 135,000,000 cu ft per day available to the mixing station, where sufficient natural gas is added, up to the limit of the available supply, to maintain a minimum pressure for the most distant consumer on the distribution system. An average of 10,000,000 cu ft per day of natural gas is introduced in this way to make a total of 145,000,000 cu ft per day of mixed gas available to the four major steel plants. Due to this addition of natural gas the heating value per cubic foot of the mixed gas is higher than that of the straight coke oven gas, and varies from 570 to 650 Btu per cu ft, averaging 590 Btu per cu ft.

Coke oven and natural gas is supplied to the Duquesne, Homestead and Edgar Thomson works of the Carnegie-Illinois Steel Corporation, and the National works of the National Tube Company, where 35 per cent is used for open hearth furnace melting fuel, 25 per

cent for soaking pit fuel, and 40 per cent in the reheating furnaces of the finishing mills. The variable fuel requirements of these plants in excess of the coke oven and natural gas supply must be met by the use of liquid fuels such as fuel oil and fuel tar, the latter making possible the disposal of this fuel as produced at the tar plant. During week-end operations, and periods of decreased fuel requirements at the various steel plants, a surplus of coke oven gas exists after natural gas has been eliminated from the mixture. In order to utilize coke oven gas during these periods it is supplied to the gas compressor station and boiler houses. These consumers may be considered as ballast on the system, which can be put on or taken off at very short notice.

The gas compressor station, having a capacity of 20,000,000 cu ft per day, is used to pump coke oven gas to a number of gas wells where it is stored for future use. It is later used either by a direct consumer from the field, or by returning it to the distribution system, as far as the relative supply and demand will permit. Two boiler houses at the coke plant, normally burning coke dust, can use 30,000,000 cu ft per day of straight coke oven gas during any period of surplus gas and thereby save the solid fuel for a reserve to meet peak demands. The accompanying sketch graphically portrays the recovery and distribution of gas at the Clairton coke plant.

## . . . . at Campbell Works

### YOUNGSTOWN SHEET AND TUBE CO.

*by H. B. HELM*

▲ THE increased interest of the steel industry in the possible savings to be had through the more economical distribution of fuels was one of the results of the dark period of 1930 to 1933. It was during this period that the Youngstown Sheet and Tube Company began a fuel conservation program at the Campbell Works by extending the use of blast furnace gas to warming two of its idle coke batteries and installing a mixing station for blast furnace gas and coke oven gas in order that a low Btu fuel might be used throughout the plant. Later, as the demand for coke gas increased, natural gas was added to the system at the mixing station. At present we are no longer diluting our coke gas with blast furnace gas but are using a mixture of blast furnace gas and natural gas equivalent to coke oven gas to assist in meeting peak demands on the system. Our system differs from most others in that the mixing station is located before the boosters, which was the least expensive location. It operates on pressures varying from 6 in. to 10 in. of water.

With the exception of the small amount of blast furnace gas used in this manner, the distribution of this fuel is entirely separate for coke gas, hence these two fuels will be discussed separately.

The surplus coke oven gas is delivered to a 360,000 cu ft holder at the rate of 1,400,000 cu ft per hour. From here it passes through the mixing station and is delivered to the system at a pressure of 4¼ psi. From this point on, under normal conditions the gas dispatcher has control of the distribution of this fuel. His office, located in the mills, is equipped with recording pressure gauges on natural gas and coke oven gas, flowmeters on natural gas, blast furnace gas and coke oven gas, and principal consumer flow meters. In addition to these, there are a gas holder position recorder and controls for introducing the makeup fuel either automatically or manually if necessary under unusual conditions. In addition to varying the quantity of makeup fuel to meet the variations in demand for coke gas, the dispatcher orders some of the mills to use coke gas or liquid fuel or natural gas depending upon conditions.

With these means of balancing demand for gaseous fuel with production, the object of gas dispatching may be said to be twofold: First, all consumers must be supplied with sufficient fuels to maintain production; second, this should be accomplished in the most economical manner possible by replacing fuel oil and natural gas first, then tar, and last, coal. Since we are equipped with a surplus gas holder, although small, we can maintain a relatively constant main line pressure, and gas dispatching resolves itself into the problem of preventing the holder from rising to the bleed point or dropping to a point where the booster operator is forced to reduce the main pressure, thereby diminishing the supply of gas to the mills.

The coke oven gas available for the mills amounts to 1,400,000 cu ft per hour, while the demand for this fuel reaches peaks of 2,000,000 cu ft per hour, or 143 per cent of the available supply. During weekends, particularly the 11-7 turns on Sundays, the demand drops to as low as 600,000 cu ft per hour, or only 43 per cent of the surplus coke gas. Since practically all mills are idle during this period of low demand, our only means of consuming this excess coke gas is to burn it under boilers or in the open hearth furnaces. This latter dumping point is used only on weekends. Gas is ordered on the open hearth (one or more furnaces at a time) through telephone contact with the open hearth foremen. However, the final decision as to whether the gas should be burned rests with each furnace first helper, whose judgment is based on type and condition of heat.

In the past, when the weekend period of low demand was considerably longer than it is now, an attempt was made to schedule a minimum of low sulphur heats to be made during these periods, since the high sulphur content of our coke gas will not permit its use when making this type of heat. As a rule the dispatcher can depend on as many as ten of the eleven operating open hearths burning gas or a total of 250,000 cu ft per hour being consumed if necessary.

Gas is ordered on the boiler houses in units of one or more boilers at a time, depending upon the situation. Eight boilers are equipped for burning gas. This dumping point consumes a maximum of 550,000 cu ft per hour, which, when added to the gas dumped to the open hearth department, will just about balance the

consumption of coke gas with production. With the exception of weekends, little gas is burned under the boilers.

Although this method of handling the distribution of coke oven gas requires an employee on duty 24 hours a day, 7 days a week, it is felt that the advantages of close supervision of this phase of fuel utilization pays excellent returns, at least under our operating conditions. Coke oven gas bled averages considerably less than one-tenth of one per cent of the total production and has been as low as 33 million Btu for an entire month.

One opportunity for further increasing savings lies in reducing the quantity of coke gas dumped to boilers and using this gas to replace the higher priced fuels, such as oil or natural gas. Some revision of our main lines is now being made to accomplish this to some degree. However, unless a plant is equipped with a large surplus gas holder or is so integrated that all variations in demand for gaseous fuels may be met by varying the quantity of a makeup fuel, the law of diminishing returns prevents the complete elimination of dumping gas to boilers or the like.

Our distribution of blast furnace gas is relatively simple. With the exception of the small amount consumed with natural gas as a makeup fuel, it is either consumed in blast furnace stoves, boilers, or bled. The gas consumed by the stoves is precipitator-cleaned, while that dumped to the boilers is only wet washed. The quantity of gas consumed by the boilers is determined by the main blast furnace line pressure, i.e., a spill-over system is used. However, if the main steam pressure rises high enough, the master boiler control takes over and reduces the amount of gas to the entire boiler house. This system of consuming the surplus blast furnace gas was installed about fifteen years ago and has proved satisfactory.

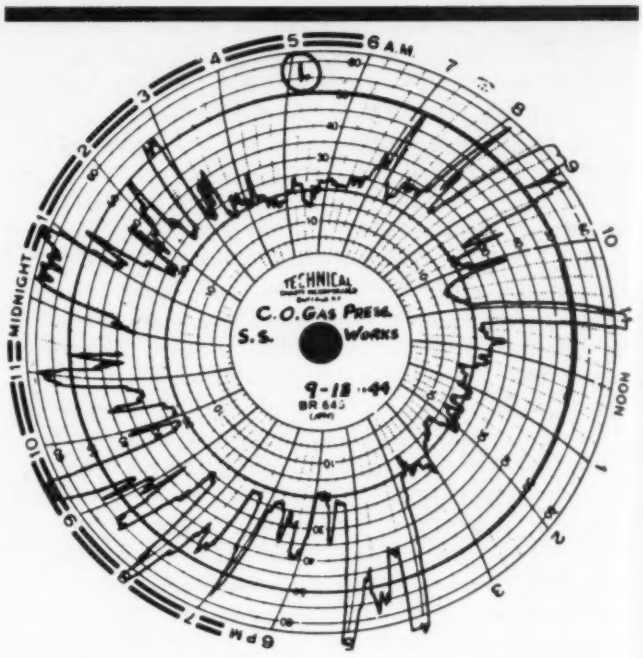



**Figure 1 — Chart showing coke oven gas pressure at South Side works of Jones and Laughlin Steel Corporation.**

## . . . . at Pittsburgh Works

### JONES AND LAUGHLIN STEEL CORP.

*by L. F. KOPSA*

▲ THE ability to utilize coke oven gas and blast furnace gas efficiently has created an increased demand for improved methods of control and equipment which will stabilize gas pressures in the lines to the consuming units.

At the Pittsburgh Works of Jones and Laughlin Steel Corporation, we produce an average of 2,500,000 cu ft of coke oven gas per hour at our by-product plant, of which an average of 48 per cent is consumed at the by-product ovens. The remainder is delivered to the mills, creating a wide fluctuation in gas pressure due primarily to the varying demands for fuel by the consuming units. No gas storage holder is available, and topped tar is used as an auxiliary fuel in some of our heating units when the demands for fuel exceed the gas production.

A gas dispatcher is on duty at all times, whose primary job is to try to maintain a main line gas pressure of between 20 and 50 ounces at the South Side Works. When the main line pressure increases, an effort is made to reduce the tar consumption and maintain the desired maximum gas pressure by asking, first, the heaters of the various steel heating furnaces, and second, the boiler house foremen to use coke oven gas. Figure 1 shows the wide fluctuations in the coke oven gas pressure at the South Side Works.

The inability to stabilize gas pressures by manual operations has caused the need for a control which will automatically swing from the burning of the auxiliary fuel to coke oven gas and vice versa, operating on a predetermined minimum or maximum line pressure. A modulating type of control was installed on two billet heating furnaces which automatically reduces or increases the tar or gas consumption when the gas pressure is respectively below or above 35 ounces, for which the control is set. This being our first experience with this type of control under the existing conditions, many changes were made to insure satisfactory operation with a minimum of maintenance. Figure 2 shows the results obtained with the use of this control.

It was not until the recent installation of new soaking pits that the application of a coke oven gas stabilizing control was incorporated in the original design and construction. These pits are fired with coke oven gas and are equipped to use topped tar as an auxiliary fuel. This control has not yet been put into operation due to difficulty in securing shut-off valves of proper design.

We are making an effort to equip our three slab heating furnaces with controls which will assist in maintaining the desired gas pressures at the various locations throughout the plant. These furnaces are triple-fired with coke oven gas and are equipped to burn topped

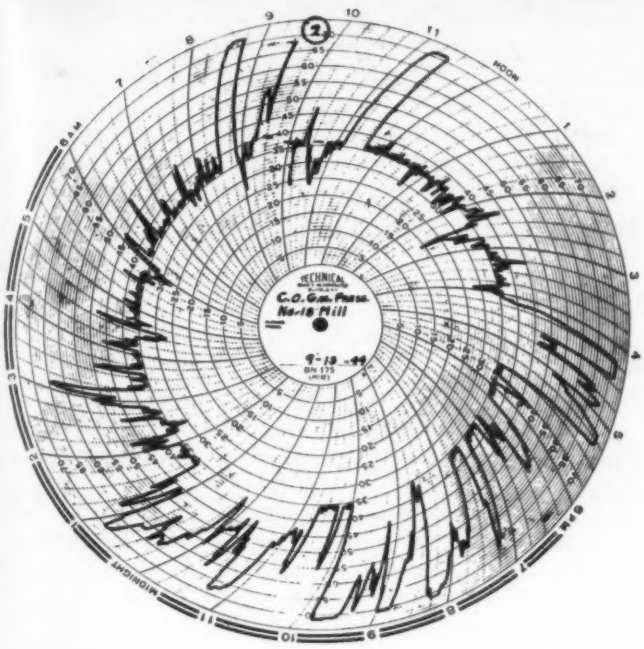
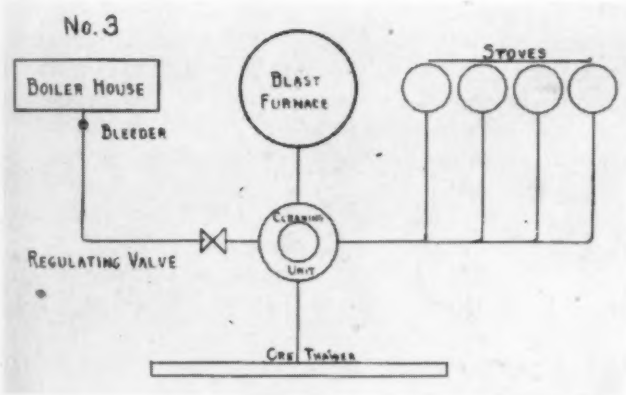



**Figure 2 — Coke oven gas pressure at No. 18 mill under modulating control.**

▲

**Figure 3 — Sketch showing schematic distribution of blast furnace gas at Pittsburgh works, Jones and Laughlin Steel Corporation.**




tar as an auxiliary fuel in the top and bottom heating zones.

The blast furnace has been looked upon generally as an iron producing unit only and up to the past several years too little has been done to efficiently utilize the blast furnace gas produced. Figure 3 is a sketch representing the consumption of blast furnace gas in our plant. Total gas production from six furnaces amounts to approximately 26,000,000 cu ft per hr. After leaving the cleaning units an average of 25 per cent is consumed by the blast furnace stoves. These stoves are equipped with flow meters, gas-air ratio controls and valves which are set to permit the passage of a predetermined amount of gas only. With 5 per cent being consumed during the cold weather months by the recently installed ore thawers and 5 per cent being charged to loss, the remainder is available for boiler consumption.

The amount of gas consumed by the boilers depends on a manually operated valve in the line ahead of the boilers, which is regulated to maintain a sufficient gas flow to the stoves and ore thawers. These boilers are equipped to burn coal as an auxiliary fuel when the demands for gas exceed the supply. Having a fluctuating gas supply and a varying steam demand, the coal is automatically controlled to provide sufficient fuel to the boilers at all times. An automatic bleeder is installed in the main line to the boilers to bleed off the gas when the gas available exceeds the demands.

Although difficulties have been encountered in an effort to utilize coke oven and blast furnace gas efficiently, they are becoming easier to overcome with the improved designs in control and burner equipment and the realization by both fuel engineers and operators that efficient production demands efficient heating.

# DISCUSSION

**PRESENTED BY**

**L. F. KOPSA, Assistant Combustion Engineer, Jones and Laughlin Steel Corporation, Pittsburgh, Pennsylvania**

**H. C. COX, Superintendent Steam and Combustion, Bethlehem Steel Company, Johnstown, Pennsylvania**

**JOHN H. BUCHHOLZ, American Steel and Wire Company, Cleveland, Ohio**

**H. V. FLAGG, Combustion Engineer, American Rolling Mill Company, Middletown, Ohio**

**E. C. McDONALD, Combustion Engineer, Republic Steel Corporation, Cleveland, Ohio**

**P. E. LEISS, Combustion and Steam Engineer, Republic Steel Corporation, Warren, Ohio**

**R. A. LYTLE, Assistant Superintendent Maintenance, Carnegie-Illinois Steel Corporation, Clairton, Pennsylvania**

**H. B. HELM, Assistant Superintendent, Fuel Department, The Youngstown Sheet and Tube Company, Youngstown, Ohio**

***R. I. GUMAER, Fuel Engineer, Jones and Laughlin Steel Corporation, Aliquippa, Pennsylvania**

***Deceased**

**L. F. Kopsa:** I would like to ask Mr. Cox whether they have a delayed time system on the lights at their open hearth. Otherwise, if their gas pressure fluctuates as much as I have seen it in our plant, the first helper would have a hard time with the gas going on and off the open hearth furnaces.

**H. C. Cox:** We do not have a delayed system on our lights. As I said before, it is entirely up to the first helper on the furnace whether he takes the gas or not. It is not very much trouble for him to use it or turn it off. If it is the right time of the heat, he will take it. If it is not the right time, he will not take it. When he gets through with it, whether the light is on or off, he will shut it off.

**John H. Buchholz:** In our Cleveland plant, we have similar conditions to those mentioned by Mr. Cox. We have about five miles of line through which we send

the coke gas from the coke plant to our finishing mills which are located quite a distance away.

Is it much of a problem to keep the coke gas lines moisture-free by use of drips, and how often do you have to pump them? Sometimes we have to pump our drips twice a day; the condition is bad, due to the gas being saturated with moisture.

**H. C. Cox:** Our pipeline system is pretty close to eight miles long and we have seven automatic seals that drop the water out by gravity, continuously, as it comes along the bottom of the line. At various other places, there are about a dozen underground tanks which collect the water and they are periodically drained by millwrights — generally once every eight hours.

**H. V. Flagg:** I want to raise one question which I would like to have answered. We all know that coke oven gas systems vary in pressure, temperature, gravity and humidity with respect to metering. What provisions have been made to take into account these variables and what success has been had? In other words, how closely can you balance your output from the coke plant with your distribution to your various consumers?

**H. C. Cox:** We meter the coke oven gas as it leaves each coke plant for the mills and of course that gives us a total quantity of surplus gas. Throughout the plant we have approximately 47 other meters which are supposed to add up to the two meters at the coke plant.

About ten years ago they did not do it very well. They were about 25 per cent low. We have established pressure and temperature recorders at 4 or 5 different places in the plant and the laboratory frequently samples the gas leaving the coke plant. With the temperature recorders and the pressure recorders to give us the average conditions during the day, and with the specific gravity that we get from the laboratory, we correct the 47 meters and now get a total running between 95 and 98 per cent of the two meters at the coke plant.

Just what happens to that other 2 to 5 per cent is problematical, but some of it goes out through the water seals. At least that is what we believe. It is lost, but it is our policy that the 47 distribution meters must total to the two at the coke plant. If they do not, we prorate the difference and charge it out to the departments using the gas.

**E. C. McDonald:** How close do your master meters come to meeting the theoretical production that the coke plant superintendent think he is making?

**H. C. Cox:** We have six batteries of coke ovens and four of them have the gas for underfiring metered; two of them do not, so we do not have an accurate check on the actual yield. The coke plant superintendent is generally not satisfied with the yield; of course he can estimate a little high on the gas for underfiring the two ovens that are not metered.

**P. E. Leiss:** In regard to Mr. Flagg's question about correction for meters, we have had occasion to check a displacement meter with an orifice flowmeter. This did not do so well at first, until we added an automatic pressure compensator, which largely corrected this variation. With this pressure compensator we obtain a correction which is on a mean pressure basis, and not on the average pressure basis as you would get by planimetering the pressure pen record.

By applying proper specific gravity (as determined from the gas analysis) as well as temperature and humidity corrections, the orifice meter will check out very closely with the displacement meter.

Due to our gas lines being underground for long stretches (up to a mile), our temperature and humidity corrections are comparatively small. Careful observations, however, should be made that the gas is not reheated or cooled in the branch lines.

**R. A. Lytle:** We do not continuously compensate the gas flow for varying conditions. We do correct for an average pressure and an average temperature and saturated gas conditions for all meters.

At the Clairton plant, we balance the consumption by individual departments against the total flow to the plant and that does balance out very close.

The surplus gas going down the river must balance against that consumed by the individual plants, also. That gas likewise is corrected for average pressure and average temperature conditions.

**H. B. Helm:** We correct for average specific gravity, temperature, pressure, etc. on the large consumers' meters and on the total meters, but in spite of that, there is a difference of approximately 5 per cent between that charged by the coke plant and the sum of the individual meters.

Of course, it is difficult to determine whether the quantity charged by the coke plant is wrong or the distribution meters are wrong. There are one or two instances where we feel the meter is not correctly installed, and when we correct that, we hope to reduce that 5 per cent.

**L. F. Kopsa:** With practically all of our large consumers, we have gas pressure regulators in the lines ahead of the orifice so it is not necessary to correct for pressure because we try to maintain — and do most of the time — the desired pressure.

On temperature, we use an average and if we run into any discrepancies with the coke plant, we have a fuel dispatcher who has been coached well and who knows how to take care of the gas charges.

**H. V. Flagg:** I might say that the reason I was interested in that question is that for the last two years I have been struggling to balance our coke gas distribution. I remember the Youngstown experience of twenty years ago when they did not even approach a 5 per cent balance. They have evidently made a lot of improvements since that time.

In our own experience of the last couple of years, by making careful corrections for the variables of temperature, pressure, gravity and humidity, we have been able to make an orifice meter check within one-half per cent against displacement metering also corrected for temperature, pressure and gravity.

However, we found that it is necessary to extend the same careful corrections for the conditions existing at each individual meter and also that orifice installations have to be watched a lot more carefully than we might feel necessary.

**R. A. Lytle:** It seems that some of these plants are using a mixture of coke oven gas, natural gas, and air. Other plants are using a mixture of air and natural gas along with coke oven gas. Also, from my understanding of the description of the operation of these plants, the

(*Please turn to page 91*)

# *Safety Procedure* IN CLEANING AND REPAIRING TANKS, GAS HOLDERS, VESSELS AND LINES

*. . . . this material was prepared and assembled by the following committee of the Sparrows Point Plant, Bethlehem Steel Company: Chairman — A. J. Fisher, Fuel Engineer; W. E. Grainger, Assistant Superintendent Coke Ovens; D. J. Branning, Assistant Superintendent Mechanical Department; J. P. O'Rourk, Safety Engineer; G. J. Campbell, Combustion Engineer Open Hearth . . . .*

▲ THE committee, in preparing the sequences outlined in these procedures, has taken the positive side of the safety problem in that the necessary safeguards and checks are provided to prevent accidents. This means that the foreman in charge of setting up the required material and personnel to do work on hazardous equipment must submit his plan of procedure to either his division superintendent or the assistant division superintendent for their personal checking and approval before the work can be started. This will prevent jobs from proceeding where: (1), the foreman has been lax or careless due to familiarity with the job, etc.; (2), where the foreman is not sufficiently trained to carry on by himself; and, (3), where time is pressing and the job would be undertaken without the proper regard for assembling the required equipment and personnel. In addition, it will give the superintendent the necessary information as to whether or not his foreman is qualified to do this kind of work without subjecting the employees and property of the plant to excessive risks.

## FUNDAMENTAL PRECAUTIONS

Working upon or entering into a closed vessel which contains explosive or toxic gases is extremely dangerous unless the proper precautions are taken. In view of this fact, a competent foreman should always be placed in charge who will remain on the job until it is completed or he is relieved.

This foreman should constantly look out for wind changes which might blow toxic gas from an adjacent unit around the men doing the cleaning or repair job. He should be particularly careful that air line pumps, if used, are kept located in a place free from obnoxious or toxic gases. He should constantly check on the men doing the job to make sure that they are doing the work in the proper sequence.

In preparing an operating unit for cleaning and maintenance which contains explosive or toxic gases, the chambers must be first purged of the explosive gases; second, purged of the toxic gases; and, third, repurged to eliminate oxygen before normal operation can be restored. This is a cycle containing three major steps, each requiring separate treatment. The operator who attempts to go through this cycle without the necessary equipment and required skill, sooner or later will meet up with a major accident.

If the units contain explosive or combustible fuels, it is necessary to purge them with either steam, burned gas, nitrogen or carbon dioxide below the lower limit of inflammability. Likewise, when these units are ready to be placed back in service they must again be filled with these same purge gases to insure that the units will be above the upper limit of inflammability when returned to service. The purging and repurging of a gas

filled unit, should never be undertaken without having someone available on the job to operate a combustible gas indicator and an orsat apparatus. The operator of these machines should be trained to make the necessary tests for safe conditions. For the necessary information and procedure see G. J. Campbell's article on Methods of Purging Gas Lines, Gas Holders, Tanks, published at the end of these procedures.

The first fundamental safety consideration of a closed tank or vessel is in the original design of the unit itself. The unit should have the proper number and size of manholes so that, if possible, they may be cleaned without anyone going inside. The manholes should be of a large size in order that men can get in and out of them easily, and they should be located in the top and bottom of the unit to facilitate natural or forced draft ventilation.

The manholes should be no fewer than two opposed 18 inch minimum diameter openings at the bottom of the tank and one 18 inch minimum diameter opening in the top of the tank; or as close to these positions as good design will permit.

Make manholes of sufficient size to relieve pressure on tank in the event of an explosion to prevent rupture of tank. This statement refers particularly to coolers and scrubbers.

No tank, vessel, or pipe line which has contained toxic or poisonous gases, vapors, or liquids should be entered if any other practical means of cleaning can be devised. Usually, a high pressure nozzled hot or cold water stream can be employed to clean most tanks from the outside provided the proper number of manholes are installed on the unit.

If the proposed job is small and compact requiring only a few men, it should be discussed thoroughly by the men involved. If it is a large one, covering considerable area where non-integrated groups of men are required, the job should be discussed in a joint meeting by the principals and a definite procedure written up giving the order in which each event should take place and its estimated time. Copies should then be issued to each of the groups who have been given definite functions to perform.

A discussion of the various tools and equipment that are necessary for cleaning and repairing hazardous tanks, vessels, gas holders, and lines is as follows:

(*a*) *Gas Masks* — The gas masks should be of the type recommended by the safety department from the approved list of the U. S. Department of Interior, Bureau of Mines.

If gas protective equipment including canister masks, fresh air hose masks, oxygen breathing apparatus, or gas testing equipment is to be used, sufficient time must be taken previous to the planned operation to thoroughly instruct all repair men or riggers involved in the use of these apparati or instruments.

If it becomes necessary in an emergency to equip an uninstructed person with any of these apparati, it should be done only under the direct supervision of a person of known qualification and experience in the handling of such equipment.

Keep the gas masks in a clean place between jobs and have same inspected regularly as per instructions from the manufacturer. One man should be given the responsibility for maintenance and care of all gas masks in a department.

(*b*) *Spark Proof Tools* — The use of spark proof tools should be strictly enforced. Tools made by the Ampco Metal, Inc., Milwaukee, Wisconsin, or equivalent are satisfactory. These are beryllium-copper hand tools and are available as wrenches, chisels, bars, hammers, mauls, shovels, picks, etc.

The tools should be examined to see that there are no particles of iron or steel embedded in the striking surfaces. While sparks will not be produced when particles of the copper alloy tool are broken off they may be created if particles of the metal being struck are broken off.

(Note — Shoes should be examined for nails which might create a spark.)

(*c*) *Lights* — Electricity, with proper safeguards, can be used in hazardous locations with a greater degree of safety than any other forms of energy for lighting. Since the problem is one of occasional entry into a normally closed tank, portable lights are necessary. These may be of two kinds, flash lights and portable electric lamps attached to a 110 volt source. Both of these light sources must be of a special type.

The ordinary flash light does not meet with the requirements of the Bureau of Mines or the Underwriters Laboratories. The flash light must be made of non-sparking metal, semi-hard rubber or some similar substance. These flash lights are equipped with a special contact for breaking the circuit in case the globe is broken by accident, and are equipped with a spare lamp bulb. These flash lights bear a special Underwriter's approval label. The flash light should not be opened or relamped while in a hazardous atmosphere. Such a flash light is the Eveready, catalog No. 1259.

The 110 volt portable lamp holder should be explosion proof and dust tight, and made of non-sparking metals. Such a lamp holder is usually made of cast aluminum with a clean Pyrex explosion-resisting globe threaded on the body and locked to prevent loosening by vibration. The guard over the globe should be a combination of cast bronze rings, and copper clad wire bows, fastened to the globe holder by machine screws. The entire fixture should be a factory assembled job. The globe holder, globe and guard are easily removed as a unit for relamping. Such a fixture is the Crouse-Hinds type EVH.

Extra hard usage, three-conductor portable cord should be used and the fixture grounded through one wire to prevent abnormal voltage stresses on the insulation or static discharges.

The fixture should never be relamped with the current on, and should not be relamped while in a hazardous atmosphere.

The receptacles for inserting the portable hand lamp must be of a special type, if used in a hazardous atmosphere. The receptacles should be explosion-proof and of such design that the plug cannot be inserted or withdrawn unless the current is off. This receptacle should be of the Crouse-Hinds type FSQ and the plug type FP or similar.

(*d*) *Forced Draft Air Blowers* — Forced ventilation in confined places to prevent the accumulation of toxic or explosive gases is a paramount safeguard. The maintenance of the proper amount of air in enclosed vessels

should be entrusted only to equipment in first class mechanical condition.

A table showing the kind of blowing recommended and the amount follows:

| Size of vessel, cu ft | Cu ft of air per minute | |
|---|---|---|
| 250 | 250 | Compressed air 2½″ inspirator |
| 500 | 500 | Compressed air 3″ inspirator |
| 1000 | 1000 | Compressed air 4″ inspirator |
| 1500 | 1500 | Compressed air 6″ inspirator |
| Larger | One change a minute or more | Steam driven blower |

## CASE I

### A METHOD OF TREATING UNITS CONTAINING LIGHT OIL, BENZOL, GASOLINE, AND OTHER HIGHLY VOLATILE AND INFLAMMABLE LIQUIDS IN TANKS, VESSELS, AND PIPE LINES; FOR CLEANING OR REPAIRING PURPOSES, WHERE MEN ARE REQUIRED TO ENTER THE UNIT.

#### ALTERNATE A — SLUDGE WASHED OUT

#### ALTERNATE B — HAND REMOVAL OF SLUDGE

Potential dangers are explosions and toxic gases.

*Item 1.* Talk over the job with all interested parties, explain the hazards, and make a schedule showing the starting times of the various sequences and who shall do them.

*Item 2.* Assemble the necessary equipment:

(a) Spark proof tools, copper shovels, etc.
(b) Lights with necessary safeguards.
(c) Forced draft air blower.
(d) Water hose, nozzles, fittings, etc.
(e) Steam hose, fittings, etc.
(f) For alternate B only.

A minimum of two hose gas masks complete with two blowers, two life lines, two safety belts, and additional spare fibre washers to prevent leakage of air from the pump to the gas masks.

*Item 3.* Have the equipment and method of procedure inspected by and get permission to proceed from, the division superintendent or his assistant.

*Item 4.* Blank off inlet and outlet connections.

*Item 5.* Leave a suitable vent open at the top of the unit and purge with steam, taking care to keep all the condensate drained out of the unit at all times.

The unit may be considered purged when its inside temperature has reached 200 to 212 F and has been maintained at that temperature for five to ten minutes.

*Item 6.* Open the top and bottom manholes and start the forced draft air blower. The blower should be connected at the bottom of the unit.

#### ALTERNATE A — SLUDGE WASHED OUT

*Item 7.a* Wash all the muck and sludge out the bottom drain hole by means of hot or cold water sprays. This work is to be done from outside the vessel.

Items 8a and 9a may be eliminated if the unit is down for cleaning purposes only.

*Item 8.a* Shut blower down, close all the manholes except one or leave open a suitable vent and purge with steam, taking care to keep all the condensate drained out of the unit at all times. The unit may be considered completely steamed out when its inside temperature has reached 200 to 212 F and has been maintained at that temperature for five to ten minutes. This steaming is required to completely volatilize all liquids from the cracks and crevices in the shell and around the internal parts of the unit.

*Item 9.a* Open all the manholes and start the forced draft air blower. The tank may now be considered safe for entry and men may enter the unit without gas masks to do repair work, necessary burning, etc., as long as the forced draft blower is running. If the blower fails, the men should come out of the unit and stay out until forced ventilation is restored.

In restricted areas around other inflammable units, burning and open fires may be prohibited. In these cases drilling, chipping, and cold riveting must take the place of burning and welding.

#### ALTERNATE B — HAND REMOVAL OF SLUDGE

*Item 7.b* Wash as much of the muck and sludge out, by means of hot or cold water sprays, as possible. This work is to be done from the outside of the vessel.

*Item 8.b* Open all the manholes and start the forced draft air blower. The unit is now ready for entry of the cleaning crew with gas masks. If the blower fails, the men should come out of the unit and stay out until forced ventilation is restored.

*Item 9.b* The cleaning crew shall consist of no fewer than four men, as follows:

(a) One man inside the unit. This man is to wear a hose mask, safety belt, and a life line and to be engaged in the actual work to be done.
(b) One man immediately outside the unit supporting and observing the workman inside the tank.
(c) One man operating the air pump to the hose mask.
(d) One man standing by as a relief man with an additional hose gas mask, safety belt, and life line who can put on same, enter the vessel, and retrieve the man inside the tank if an emergency should arise.
(e) Men inside the tank equipped with gas masks should work 10 to 15 minute periods. They should then come out of the tank, for fresh air, for at least a 5 minute period.

*Item 10.b* In removing the muck and sludge from the bottom of the tank, be careful not to let the men shovel it up into piles within the tank; have them get their shovels full and walk to the manhole and throw the material out of the tank. This method will liberate a minimum of the gas contained in the sludge while it is in the unit.

*Item 11.b* After shoveling is completed, thoroughly wash the unit with hot or cold water sprays. This should be done from outside the unit, or with the men wearing gas masks inside the unit.

Items 12b and 13b may be eliminated if the unit is down for cleaning purposes only.

*Item 12.b* Shut blower down, close all the manholes

except one or leave open a suitable vent and purge with steam, taking care to keep all the condensate drained out of the unit at all times. The unit may be considered completely steamed out when its inside temperature has reached 200 to 212 F and has been maintained at that temperature for five to ten minutes. This steaming is required to completely volatilize all liquids from the cracks and crevices in the shell and around the internal parts of the unit.

*Item 13.b* Open all the manholes and start the forced draft blower. The unit may now be considered safe for entry and men may enter the unit without gas masks to do the necessary repair work, burning, etc., as long as the forced draft blower is running. If the blower fails the men should come out of the unit and stay out until forced ventilation is restored. In restricted areas around other inflammable units, burning and open fires may be prohibited. In these cases drilling, chipping and cold riveting must take the place of burning and welding.

*Item 7.* When the work is completed, shut the blower down and replace the manholes, except the top one, or leave open a suitable vent, and repurge with burned gas, nitrogen, or carbon dioxide above the upper limit of inflammability. Test for probable explosive conditions with the orsat apparatus.

*Item 8.* Remove the blanks on the inlet and outlet connections. Fill the unit with the working liquid from the bottom, exhausting the inert gas at the top. Place unit in operation.

## CASE 2

### A METHOD OF TREATING UNITS CONTAINING TAR, HEAVY FUEL OIL, AND OTHER NON-VOLATILE LIQUIDS IN TANKS, VESSELS, AND PIPE LINES; FOR CLEANING OR REPAIRING PURPOSES.

Potential dangers are from fire caused by burning steel plates or sections.

*Item 1.* Talk over the job with all interested parties, explain the hazards, and make a schedule showing the starting times of the various sequences and who shall do them.

*Item 2.* Assemble the necessary equipment.

(a) Standard steel tools, shovels, etc.
(b) Standard lights.
(c) Force draft air blower.

*Item 3.* Have the equipment and method of procedure inspected by, and get permission to proceed from, the division superintendent or his assistant.

*Item 4.* Blank off inlet and outlet connections.

*Item 5.* When the unit is cooled to atmospheric temperatures, open the manholes and start the forced draft air blower. The blower should be connected to the bottom of the tank. The tank may now be considered safe for entry and men may enter the unit without gas masks to do the necessary work as long as the forced draft blower is running. If the blower fails, the men should come out of the unit and stay out until forced ventilation is restored.

*Item 6.* Clean the tank of all sludge and oily material.

*Item 7.* Do necessary repairs, burning, welding, etc. In restricted areas around other inflammable units, burning and open fires may be prohibited. In these cases drilling, chipping, and cold riveting must take the place of burning and welding.

*Item 8.* When the work is completed shut the blower down, remove the blanks, and place the unit in service.

## CASE 3

### A METHOD OF TREATING COMBUSTIBLE GAS FILLED TANKS, VESSELS, HOLDERS, AND PIPE LINES; FOR CLEANING OR REPAIRING PURPOSES, WHERE MEN ARE REQUIRED TO ENTER THE UNIT.

#### ALTERNATE A — SLUDGE WASHED OUT

#### ALTERNATE B — HAND REMOVAL OF SLUDGE

Potential dangers are explosions and toxic gases.

*Item 1.* Talk over the job with all interested parties, explain the hazards, and make a schedule showing the starting times of the various sequences and who shall do them.

*Item 2.* Assemble the necessary equipment:

(a) Spark proof tools, copper shovels, etc.
(b) Lights with necessary safeguards.
(c) Forced draft air blower.
(d) Water hose, nozzles, fittings, etc.
(e) Steam hose, fittings, etc.
(f) For alternate B only:

A minimum of two hose gas masks complete with two blowers, two life lines, two safety belts, and additional spare fibre washers to prevent leakage of air from the pump to the gas masks.

*Item 3.* Have the equipment and method of procedure inspected by, and get permission to proceed from, the division superintendent or his assistant.

*Item 4.* Blank off inlet and outlet connections or seal same with water.

*Item 5.* Purge with steam, burned gas, nitrogen, or carbon dioxide below the lower limit of inflammability. If steam is used, the unit may be considered purged when its inside temperature has reached 200 to 212 F and has been maintained at that temperature for five to ten minutes. Test for explosive conditions with a U. S. Bureau of Mines approved explosive gas indicator.

If a section of the unit has to be isolated because of a mechanical change or repair, provide forced air ventilation in each isolated section.

*Item 6.* Open the top and bottom manholes or other suitable openings. Start the forced draft air blower. The blower should preferably be connected at the bottom of the unit.

#### ALTERNATE A — SLUDGE WASHED OUT

*Item 7.a* Wash as much of the muck and sludge out, by means of hot or cold water sprays, as possible. This work is to be done from the outside of the vessel.

In many cases, the gases used are clean and therefore there is no dirt or sludge to be taken from the unit. If, however, there is a small amount of dirt and it is decided not to remove it from the unit, care should be taken

not to disturb or move this dirt because of the possibility of liberating toxic gases.

*Item 8.a* The tank may now be considered safe for entry and men may enter the unit without gas masks to do repair work, necessary burning, etc., as long as the forced draft blower is running. If the blower fails, the men should come out of the unit and stay out until forced ventilation is restored.

In restricted areas around other inflammable units, burning and open fires may be prohibited. In these cases drilling, chipping and cold riveting must take the place of burning and welding.

### ALTERNATE B — HAND REMOVAL OF SLUDGE

*Item 7.b* Wash as much of the muck and sludge out, by means of hot or cold water sprays, as possible. This work is to be done from the outside of the vessel.

*Item 8.b* Open all the manholes and start the forced draft air blower. The unit is now ready for entry of the cleaning crew with gas masks. If the blower fails, the men should come out of the unit and stay out until forced ventilation is restored.

*Item 9.b* The cleaning crew shall consist of no fewer than four men, as follows:

(a) One man inside the unit. This man is to wear a hose mask, safety belt, and a line life and to be engaged in the actual work to be done.
(b) One man immediately outside the unit supporting and observing the workman inside the tank.
(c) One man operating the air pump to the hose mask.
(d) One man standing by as a relief man with an additional hose gas mask, safety belt, and life line who can put on same, enter the vessel, and retrieve the man inside the tank if an emergency should arise.
(e) Men inside the tank equipped with gas masks should work 10 to 15 minute periods. They should then come out of the tank, for fresh air, for at least a 5 minute period.

*Item 10.b* In removing the muck and sludge from the bottom of the tanks, be careful not to let the men shovel it up into piles within the tank; have them get their shovels full and walk to the manhole and throw the material out of the tank. This method will liberate a minimum of the gas contained in the sludge while it is in the unit.

*Item 11.b* After shoveling is completed, thoroughly wash the unit with hot or cold water sprays. This should be done from outside the unit, or with the men wearing gas masks inside the unit.

*Item 12.b* The unit may now be considered safe for entry and men may enter the unit without gas masks to do the necessary repair work, burning, etc., as long as the forced draft blower is running. If the blower fails, the men should come out of the unit and stay out until forced ventilation is restored.

In restricted areas around other inflammable units, burning and open fires may be prohibited. In these cases drilling, chipping and cold riveting must take the place of burning and welding.

* * * *

*Item 7.* When the work is completed, shut the blower down and replace the manholes, except the top one, or leave open a suitable vent, and repurge with steam, burned gas, nitrogen, or carbon dioxide above the upper limit of inflammability. If steam is used, the unit may be considered purged when its inside temperature has reached 200 to 212 F and has been maintained at that temperature for five to ten minutes. Test for probable explosive conditions with the orsat apparatus if inert gas is used.

*Item 8.* Remove the blanks on the inlet and outlet connections. Fill the unit with the working gas from the bottom, exhausting the steam or inert gas at the top. Place unit in operation.

## CASE 4

### A METHOD OF TREATING SULPHURIC ACID FILLED TANKS, VESSELS, AND PIPE LINES; FOR CLEANING OR REPAIRING PURPOSES, WHERE MEN ARE REQUIRED TO ENTER THE UNIT.

### ALTERNATE A — SLUDGE WASHED OUT

### ALTERNATE B — HAND REMOVAL OF SLUDGE

Potential dangers are explosions, and acid burns.

*Item 1.* Talk over the job with all interested parties, explain the hazards, and make a schedule showing the starting times the various sequences and who shall do them.

*Item 2.* Assemble the necessary equipment:

(a) Rubber gloves, rubber boots, rubber aprons, goggles, seamans oil skin trousers, and seamans oil skin jackets.
(b) Spark proof tools, copper shovels, etc.
(c) Lights with the necessary safeguards.
(d) Forced draft blower.
(e) Water hose, nozzles, fittings, etc.
(f) Steam hose, fittings, etc.
(g) Lime water for neutralizing the inside of the unit.
(h) Bicarbonate of soda water for neutralizing acid burns.

*Item 3.* Have the equipment and method of procedure inspected by, and get permission to proceed from, the division superintendent or his assistant.

*Item 4.* Blank off inlet and outlet connections.

*Item 5.* Open the top and bottom manholes and start the forced draft air blower. The blower should be connected at the bottom of the unit.

### ALTERNATE A— SLUDGE WASHED OUT

*Item 6.a* Wash all the muck and sludge out the bottom drain hole. This work is to be done from outside the vessel.

Items 7a, 8a, and 9a may be eliminated if the unit is down for cleaning purposes only.

*Item 7.a* Shut blower down, close all the manholes except one or leave open a suitable vent and purge with steam, taking care to keep all the condensate drained out of the unit at all times. The unit may be considered completely steamed out when its inside temperature has reached 200 to 212 F and has been maintained at that temperature for five to ten minutes. This steaming is required to completely volatilize all

liquids from the cracks and crevices in the shell and around the internal parts of the unit.

*Item 8.a* Open all the manholes and start the forced draft blower. Spray the inside of the tank with a lime solution. This will neutralize any of the remaining acid and prevent the formation of hydrogen.

*Item 9.a* The tank may now be considered safe for entry and men may enter the unit without gas masks to do repair work, necessary burning, etc., as long as the forced draft blower is running. If the blower fails, the men should come out of the unit and stay out until forced ventilation is restored.

In restricted areas around other inflammable units, burning and open fires may be prohibited. In these cases drilling, chipping, and cold riveting must take the place of burning and welding.

#### ALTERNATE B — HAND REMOVAL OF SLUDGE

*Item 6.b* If all the muck and sludge cannot be removed by means of hot or cold water sprays, then the material must be removed by hand. Connect the forced draft air blower to the bottom of the tank and start it to operate. If the blower fails, the men should come out of the unit and stay out until forced ventilation is restored.

*Item 7.b* The men cleaning the inside of the unit must wear complete acid protective clothing. In removing the muck and sludge from the bottom of the tank, be careful not to let the men shovel it up into piles within the tank; have them get their shovels full and walk to the manhole and throw the material out of the tank. This method will liberate a minimum of the gas contained in the sludge while it is in the unit.

Items 8b, 9b, and 10b may be eliminated if the unit is down for cleaning purposes only.

*Item 8.b* Shut blower down, close all the manholes except one or leave open a suitable vent and purge with steam, taking care to keep all the condensate drained out of the unit at all times. The unit may be considered completely steamed out when its inside temperature has reached 200 to 212 F and has been maintained at that temperature for five to ten minutes. This steaming is required to completely volatilize all liquids from the cracks and crevices in the shell and around the internal parts of the unit.

*Item 9.b* Open all the manholes and start the forced draft air blower. Spray the inside of the tank with a lime solution. This will neutralize any of the remaining acid and prevent the formation of hydrogen.

*Item 10.b* The tank may now be considered safe for entry and men may enter the unit without gas masks to do the repair work, necessary burning, etc., as long as the forced draft blower is running. If the blower fails, the men should come out of the unit and stay out until forced ventilation is restored.

In restricted areas around other inflammable units, burning and open fires may be prohibited. In these cases drilling, chipping, and cold riveting must take place of burning and welding.

* * * *

*Item 6.* Shut the blower down and remove the blanks on the inlet and outlet connections. Fill the unit with sulphuric acid and place the unit in operation.

## CASE 5

**A METHOD OF TREATING AMMONIA FILLED TANKS, VESSELS, AND PIPE LINES; FOR CLEANING OR REPAIRING PURPOSES, WHERE MEN ARE REQUIRED TO ENTER THE UNIT.**

#### ALTERNATE A — SLUDGE WASHED OUT

#### ALTERNATE B — HAND REMOVAL OF SLUDGE

Potential dangers are explosives; skin, nose, and throat burns; and eye irritation.

*Item 1.* Talk over the job with all interested parties, explain the hazards, and make a schedule showing the starting times of the various sequences and who shall do them.

*Item 2.* Assemble the necessary equipment:

(a) Rubber gloves, rubber boots, rubber aprons, goggles, seamans oil skin trousers, and seamans oil skin jackets, all soaked and wetted down with water prior to active use.
(b) Ammonia masks to meet any emergency.
(c) Spark proof tools, copper shovels, etc.
(d) Lights with the necessary safeguards.
(e) Forced draft blower.
(f) Steam hose, fittings, etc.
(g) Water hose with coarse and fine spray nozzles.
(h) For alternate B only:

Two hose gas masks complete with two blowers, two life lines, two safety belts, and additional spare fibre washers to prevent leakage of air from the pump to the gas masks.

*Item 3.* Have the equipment and method of procedure inspected by, and get permission to proceed from, the division superintendent or his assistant.

*Item 4.* Blank off inlet and outlet connections. "If liquid ammonia has been released, its high solubility in water may be utilized to control the escape of ammonia gas. Flooding with a large volume of water from a fine spray hose nozzle will lessen vaporization as the vapor pressure of ammonia in water is much less than that of liquid ammonia. Liquid ammonia should not be neutralized with acid — the heat generated by their reaction may increase the fumes."

*Item 5.* Open the top and bottom manholes and start the forced draft air blower. The blower should be connected at the bottom of the unit.

#### ALTERNATE A — SLUDGE WASHED OUT

*Item 6.a* Wash all the muck and sludge out the bottom manhole by means of hot or cold water sprays. This work is to be done from outside the vessel.

Items 7a and 8a may be eliminated if the unit is down for cleaning purposes only.

*Item 7.a* Shut blower down, close all the manholes except one or leave open a suitable vent and purge with steam, taking care to keep all the condensate drained out of the unit at all times. The unit may be con-

sidered completely steamed out when its inside temperature has reached 200 to 212 F and has been maintained at that temperature for five to ten minutes. This steaming is required to completely volatilize all liquids from the cracks and crevices in the shell and around the internal parts of the unit.

*Item 8.a* Open all the manholes and start the forced draft air blower. The tank may now be considered safe for entry and men may enter the unit without gas masks to do repair work, necessary burning, etc., as long as the forced draft blower is running. If the blower fails, the men should come out of the unit and stay out until forced ventilation is restored.

In restricted areas around other inflammable units, burning and open fires may be prohibited. In these cases drilling, chipping, and cold riveting must take the place of burning and welding.

### ALTERNATE B — HAND REMOVAL OF SLUDGE

*Item 6.b* Wash as much of the muck and sludge out, by means of hot or cold water sprays, as possible. This work is to be done from the outside of the vessel.

*Item 7.b* Open all the manholes and start the forced draft air blower. The unit is now ready for entry of the cleaning crew with gas masks. If the blower fails, the men should come out of the unit and stay out until forced ventilation is restored.

*Item 8.b* The men cleaning the inside of the unit must wear complete protective clothing. The cleaning crew shall consist of no fewer than four men as follows:

(a) One man inside the unit. This man is to wear a hose mask, safety belt, and a life line and to be engaged in the actual work to be done.
(b) One man immediately outside the unit supporting and observing the workman inside the tank.
(c) One man operating the air pump to the hose mask.
(d) One man standing by as a relief man with an additional hose gas mask, safety belt, and life line who can put on same, enter the vessel, and retrieve the man inside the tank if an emergency should arise.
(e) Men inside the tank equipped with gas masks should work 10 to 15 minute periods. They should then come out of the tank, for fresh air, for a 5 minute period.

*Item 9.b* In removing the muck and sludge from the bottom of the tank, be careful not to let the men shovel it up into piles within the tank; have them get their shovels full and walk to the manhole and throw the material out of the tank. This method will liberate a minimum of the gas contained in the sludge while it is in the unit.

*Item 10.b* After shoveling is completed, thoroughly wash the unit with hot or cold water sprays. This should be done from outside the unit, or with the men wearing gas masks inside the unit.

Items 11b and 12b may be eliminated if the unit is down for cleaning purposes only.

*Item 11.b* Shut blower down, close all the manholes except one or leave open a suitable vent and purge with steam, taking care to keep all the condensate drained out of the unit at all times. The unit may be considered completely steamed out when its inside temperature has reached 200 to 212 F and has been maintained at that temperature for five to ten minutes. This steaming is required to completely volatilize all liquids from the cracks and crevices in the shell and around the internal parts of the unit.

*Item 12.b* Open all the manholes and start the forced draft blower. The unit may now be considered safe for entry and men may enter the unit without gas masks to do the necessary repair work, burning, etc., as long as the forced draft blower is running. If the blower fails, the men should come out of the unit and stay out until forced ventilation is restored.

In restricted areas around other inflammable units, burning and open fires should be prohibited. In these cases drilling, chipping, and cold riveting must take the place of burning and welding.

* * * *

*Item 6.* Shut the blower down and remove the blanks on the inlet and outlet connections. Fill the unit with liquid ammonia from the bottom, exhausting air at the top. Place unit in operation.

## FIRST AID

### ARTIFICIAL RESPIRATION — SCHAEFFER PRONE PRESSURE METHOD

Lay the patient on his belly, one arm extended directly overhead, the other bent at the elbow, and turn the face outward from the extended arm so the side of the face will rest on the hand or forearm of the bent arm, and the nose and mouth will be free for breathing.

Kneel, straddling the patient's thighs with your knees placed such a distance from the hip bones as will allow you to place the palms of the hands on the small of the back with the fingers resting on the ribs, the little finger just touching the lowest floating rib, the thumb and fingers in a natural position, and the tips of the fingers just out of sight on the sides of the trunk.

With arms held straight, swing forward slowly, so that the weight of your body is gradually brought to bear upon the patient. The shoulder should be directly over the heel of the hand at the end of the forward swing. Do not bend the elbows.

Now, swing backward immediately to remove the pressure completely. After two seconds swing forward again. Thus, repeat deliberately 12 to 15 times a minute the double movement of compression and release, a complete respiration in four to five seconds.

As soon as artificial respiration has been started, and while it is being continued, an assistant should loosen any tight clothing about the patient's neck, chest, or waist. Keep the patient warm. Do not give any liquids whatever by mouth until the patient in fully conscious.

Resuscitation should be given in a safe place nearest possible to that where the patient received his injuries. He should not be moved from this point until he is breathing normally of his own volition, and then moved only in a lying position. Should it be necessary, due to extreme weather or other conditions, to move a patient before he is breathing normally, resuscitation should be continued while he is being moved.

### GAS POISONING

*A. Symptoms* — The symptoms are numerous, the more pronounced being yawning, giddiness, ringing in the ears, weariness and a lazy feeling in the legs. If a person gets out of gas-contaminated air into fresh air, these symptoms usually pass off. If no attention is paid to the symptoms and the person continues working, he feels his legs getting weak, he staggers, and finally falls semi-conscious or unconscious. The symptoms may develop so gradually, however, that the body becomes full of the poison and the person falls unconscious before becoming aware of the danger.

*B. Treatment* — Get victim to fresh air and give artificial respiration at once.

2. When giving artificial respiration, administer oxygen if available.
3. Keep victim warm.
4. Keep the victim lying down and at rest to avoid any strain on the heart. Later, he should be given plenty of time to rest and recuperate.
5. In case the victim becomes violent, restrain him so that he does not injure himself.
6. Send patient to the dispensary for final treatment.

### HEAT AND ACID BURNS

*A. Treatment* — 1. Remove all loose clothing from injured areas; any that adheres to the skin should be cut around and left in place.

2. In case of alkali or acid burns, wash injured area freely with large quantities of clean water.
3. Cover burned area quickly with a protective dressing and bandage.
4. Treat for shock.
5. In severe cases simply cover burned areas with sterile dressings and get victim to a hospital quickly.

### AMMONIA BURNS

*A. Treatment* — 1. Remove affected person to a place where there is fresh air. Place the patient flat on his back in relaxed position. Keep the patient quiet and warm. If necessary, prevent chilling by wrapping in blankets and warming with hot water bottles. The patient should be guarded against exposure to draft, especially if perspiring freely, and should not be excited or exercised unduly.

2. If patient is unconscious, use prone pressure (Schaeffer) method of artificial respiration. Make certain that a pulmotor or other mechanical means of resuscitation is not applied. The use of such equipment may rupture the lungs of the patient.
3. *Eye Irritation.* Hold the lids open and flush with water, then 2 per cent boric acid solution over the eyeball.
4. *Skin Burns* — Remove ammonia-soaked clothing. Rinse thoroughly with water. Send at once to a hospital.

All users of ammonia should have a first aid cabinet containing the necessary supplies required to properly treat ammonia injuries.

## METHODS FOR PURGING GAS LINES, HOLDERS, TANKS, ETC.

**by G. J. CAMPBELL**

*This paper is a revision of a paper by the same author published in A. I. S. E. Proceedings*, 1940, p. 388.

▲ THE purpose of this section is to outline some of the common hazards, and their prevention, in connection with vessels containing fuels capable of producing rapid expansions or explosions when mixed with the proper amount of air.

When a gas line, holder, or tank containing inflammable gas or fluid is opened to the atmosphere, allowing air to enter, an explosive mixture will result. Likewise, if the gas line, holder or tank contains air and an inflammable gas or fluid is introduced, an explosive mixture will be present.

In order to eliminate the fire hazard when it is necessary to open vessels containing inflammable materials, it is recommended practice to purge such apparatus with an inert gas, to the point where the resultant mixture is non-explosive when mixed with air in any proportion.

Before going further with this section, I would like to call to your attention a few of the terms used in connection with purging.

Lower limit of inflammability or lower explosive limit of a combustible gas or vapor, is the lowest concentration of the gas or vapor (in air) that will burn without the continuous application of heat from an external source.

Upper limit of inflammability or upper explosive limit of a combustible gas or vapor is the highest concentration of that gas or vapor (in air) that will burn. Above the upper limit the large amount of combustible gas acts as a diluent and combustion cannot be self-propellant.

The explosive limit is the concentration of a combustible gas or vapor between the lower and upper limits of inflammability.

The propagation of flame in an inflammable gas-air mixture is a term used to designate a flame passing through a combustible gas mixture and caused by actual burning of the gas; the speed of flame propagation is the rate at which a flame will propagate through a combustible gas mixture. This rate varies with the concentration of and the type of gas. In general the highest speed of flame propagation is encountered at approximately the theoretical gas-air mixture necessary for complete combustion.

The end point is the point at which a mixture of the inert purge gas — combustible gas mixture plus air will not burn under any provocation.

An inert gas is a gas that will not enter readily into chemical reaction and is, therefore, not combustible. It is dangerous only where it is allowed to drop the oxygen content of an atmosphere below the point where a man may work safely (about 16 per cent).

The inert gases commonly used for purging are nitrogen, and carbon dioxide, or a mixture of the two.

One of the simplest and easiest ways of purging short lines or small vessels is to use nitrogen or carbon dioxide from bottles. Each bottle or cylinder contains about 300 cu ft of gas and is usually sufficient for purging about 250 ft of 12 in. line. Nitrogen is not quite as

efficient as carbon dioxide. On the other hand, carbon dioxide is more difficult to handle due to the freezing of regulators and gauges when it is discharged from the bottle. Because the regulators do freeze, a special regulator must be used with carbon dioxide while only an ordinary oxygen regulator is required for nitrogen.

For purging large lines, from 24 in. to 84 in. diameter, liquid carbon dioxide, stored at 300 psi and 0 F, may be discharged into the line through a suitable nozzle. The nozzle should face in the direction of purging. The rate of discharge is dependent upon the nozzle openings, and is normally very rapid. This permits rapid purging with less intermixing of inert with gas or air, and requires ample bleeding capacity. The carbon dioxide is supplied from a truck or permanent refrigerated storage tank. This method is not recommended for lines with sludge or dirt, because the rate of purging is not sufficiently controllable to continue slow purging while working on the line. When orsat analyses show 85 per cent carbon dioxide it is safe to burn or weld on the line. If men must enter the line it must first be cleared of the carbon dioxide, and then checked by orsat for sufficient oxygen and by a carbon monoxide indicator.

When using bottled inert gas and purging from air to gas, the only test necessary is one which will give an indication of the oxygen content of the mixture leaving the extreme end of the line being purged. This can be done with an orsat apparatus. The oxygen should be brought down to 3 per cent or less. In going from gas to air, a combustible gas indicator must be used. If men are to work in line or vessel, or in path of purge gas or mixture, a carbon monoxide indicator should be used, as well as checking the carbon monoxide indicator with orsat analyses.

In purging long lines or large vessels, a machine is used to manufacture the inert gas. This machine consists of a burner which can burn gas or oil, usually gas. The products of combustion are cooled and pumped into the vessel to be purged. Frequent orsat readings must be taken of the products of combustion, to keep the carbon monoxide and oxygen content as low as possible. The ideal condition would be to have no oxygen or carbon monoxide present, but as this cannot always be done, it is preferable to keep a very slight excess of oxygen to make certain that all the combustible gas is burned. The maximum safe limit is 2 per cent oxygen and 0.2 per cent carbon monoxide.

The same tests on the vessel being purged can be used as outlined for bottled gas.

Another source of inert gas for purging is de-oxidizing gas machines. By adjusting a gas machine so as to have completely burned gas, an inert gas is available which can be piped to wherever it is convenient.

When purging a line from air to inert gas to combustible gas, it has been pointed out that the only test necessary is with an orsat, in order to determine the oxygen content of the air-inert gas mixture.

When purging a line or vessel which contains a combustible gas, tests must be of the type where a portion of the combustible inert gas mixture is actually burned, and they should be continued until the end point is reached.

There are acceptable combustible gas indicators for this service on the market. In operation, the indicator utilizes the effect of combustion of inflammable gas air mixtures on the surface of a glowing filament. This combustion increases the temperature and consequently the electrical resistance of the filament circuit, causing the needle of a meter to move over its scale. The scale is calibrated to read per cent explosibility, assuming that all lower explosive limits are 100 per cent explosive.

In operation, a sample is aspirated from the testing location and drawn through the combustion chamber which contains the active or testing element. Here it burns upon the glowing filament wire, causing the changes in resistance when inflammable gases are present. At the start of the purging operation the gas valve to the instrument is barely opened and the air dilution valve is left wide open. The meter reading will probably be off scale, indicating a high concentration of combustible gas. Periodic samples should be taken as purging progresses until the meter reading is on the scale. As purging progresses periodic samples should be taken, allowing more gas to enter the instrument until a point is reached where full opening of the gas sample valve and various air valve settings do not read over 5 on the scale. This indicates that the atmosphere contains a nominal amount of inflammable gas and is considered non-inflammable but toxic.

It is highly desirable to check an apparatus of this kind with an orsat during purging operations as a safeguard against the instrument being off calibration.

Very often a sample from the vessel being purged is trapped in a bomb, removed to a safe distance and then ignited. Naturally, if it does not burn further purging is unnecessary. This is not recommended as it is bad practice.

All gas-air mixtures have a definite explosive range, depending chiefly upon the relative percentage of gas-air present in the mixtures. At either end of this explosive range lies a gas and air mixture that will not explode under any provocation. Theoretically, then, all of the gas need not be purged from the apparatus before air can be safely turned into it. The question next arises as to how long purging must continue.

As we know, the two explosive limits of a combustible gas have a very definite and characteristic value. The factors involved in the explosion are, however, so complicated that no one has yet devised a satisfactory method for their accurate prediction and the values have to be experimentally predetermined in a suitable laboratory apparatus.

If the combustible gas is diluted with some inert gas, the explosive limits of the mixture in air are changed. The change depends upon the nature and the amount of the inert gas added, but the direction and the degree of the change are unpredictable by any method yet known, and must be experimentally determined. In general, the lower limits of such mixtures are raised with increased dilution with inerts, but the upper limits may be either raised or lowered and may even be raised in the presence of one inert and lowered in the presence of another. The limits of many gases are narrowed by dilution with an inert gas, but the limits of some are widened, the differences between them being even more than doubled in certain cases as the dilution by inert gas is increased. The effect of each diluent must be separately investigated.

We know that all the gas need not be purged from a vessel to make it safe, but, as we do not know where the

safe end point will be in the diluted gas-inert mixture, it is good practice to over purge until the gas indicator tester shows no explosive gas present. When a purging machine or gas machine is used, the analysis of the purge gas at the point of bleeding should be compared with the analysis at the machine. These samples should be of almost the same analysis before purging is considered complete, particularly with respect to oxygen and carbon monoxide. This is particularly important where the combustible gas is low in carbon monoxide content. Another good check is to continue the purging until the purge vapors contain less than 1¼ per cent of combustible gases.

There are a few points to bear in mind during and after the purging operation.

1. Always keep a positive pressure on the line or vessel being purged.
2. Be sure all water is drained from drips, etc.
3. Before allowing anyone without a gas mask to enter the purged container, it must be thoroughly aired until free from toxic gases and oxygen deficiency.
4. In purging coke oven gas lines, oil tanks, benzol scrubbers, etc., where light oil is present, it will be difficult to reach an end point because of the tendency of the oils to continue to vaporize. This is especially true in wooden grid scrubbers or cleaners, which have absorbed a large quantity of oil. Using a purging machine, unless leakage from gas shut-off occurs a suitable end point can be obtained if bleeder samples are compared with sample at purging machine and if purge gas flow is reasonable. If it is not necessary for men to enter the line or vessel the purge gas should be kept flowing while work progresses. No line or vessel should be purged from combustible to inert to air unless it is essential to have air in the line or vessel.
5. The incoming gas line should be sealed off at the start of the purging cycle. When men are to work inside a line or vessel that has been in gas service, a positive seal or blank should always be installed.
6. When purging from air to inert gas to combustible gas, be sure that all of the inert combustible gas mixture is bled from the line before the line is put into burning equipment service.
7. When bleeding a gas line, etc., of combustible gas or inert gas or mixtures of either with air, the bleeding should be done through a conventional premixed fire check and burner.

All the data and information which follows is taken from technical papers published by the American Gas Association, and written by R. E. Kruger, superintendent of gas manufacturing, Rochester Gas and Electric Company, and J. S. Yeaw and Louis Shnidman, also of the Rochester Gas and Electric Company.

In their study of the extinction of gas flames by steam, Yeaw and Shnidman found that in almost all cases, steam was found to be equivalent to and in some instances superior to inert carbon dioxide in its quenching effect on flame propagation. Nitrogen was found to be much weaker than either steam or carbon dioxide.

As an example, experiments conducted with manufactured gas of 538 Btu showed it required 10.8 volumes of nitrogen, 6.0 volumes of carbon dioxide, but only 5.3 volumes of water vapor per volume of combustible to render all mixtures of manufactured gas and air non-inflammable.

As pointed out by Kruger in his paper, a very notable example of the effectiveness of steam purging appears each time the base of a water gas generator is purged by steam after a down run and prior to going into a blasting period. Each time the operator neglects to purge the blue gas from the base of the generator with steam, an explosion occurs.

One of the drawbacks of steam purging is the difficulty in determining when an end point is reached, or in other words, to know definitely when the purging operation is complete. Until the entire contents of the line or vessel reaches a minimum of 212 F there is no possibility of steam completely displacing gas or air. In purging from gas to steam to air, the air can only enter at the purge bleeder. Therefore to get air in the line, drafting is necessary. With the difficulty of determining the end point and due to the high temperature required, this method of purging is not recommended except where other inert gas methods are not practicable.

When we put steam under slight pressure into the vessel being purged it will force out the gas and soon both steam and gas will be leaving the exit vent. Now steam when cooled to atmospheric temperatures will condense to water, but air and gas at the same temperature will not condense. Therefore, if a sample of the exit gas and vapors is trapped and condensed, a direct indication of the proportion of steam-gas mixture will result.

A steam purge indicator has been developed which is similar in operation to an ordinary orsat sampling tube and bottle. The sample is trapped in the tube and then condensed by the water in the leveling bottle. Steam is condensed to water so the balance of the sample must be gas.

If the sampling tube fills completely with water, then no gas is present in the purge vapors. When the purge vapors have been brought down to less than 1¼ per cent gas, it is safe to consider the purge complete.

As was pointed out in an earlier paragraph, it must be remembered that in all purging operations where light oils, naphthalene, sludge or other volatile materials are present, the purging operation is not complete until this material has been bodily removed or "topped." The complete elimination of oil from an apparatus like a light oil scrubber with soaked wooden grids is hardly possible with inert purging alone. As the rate of volatilization of the oils is largely a function of temperature and as steam supplies this temperature it follows, therefore, that steam is the logical purging agent for this type of work. In an apparatus where light oils are present, it is very likely that all gas will be purged from the vessel long before all the light oils are vaporized. When this is the case, purging must continue until less than 5 per cent of the condensate is oil. When steam can no longer volatilize 5 per cent or more oil, then air at atmospheric temperature cannot volatilize that oil and the apparatus is ready to be opened to the air.

The following method is recommended for measuring the oil condensate.

An ordinary condensing coil of about 20 ft of ¼ in. copper tubing is attached to the exit where the purge readings were taken. The purge vapors, consisting of steam and oil vapors, are condensed and caught in an ordinary 100 cc beaker. The water of course will settle to the bottom and oil at the top. Presumably steam

may be shut off when the sample reads 5 per cent but it so happens that there is not a direct relationship between the amount of steam passing through the apparatus and the amount of oil being removed. For this reason we change the steaming rate by cutting it in about half and take another series of samples. Unless the apparatus is completely purged the percentage of oil will increase.

The reason behind this increase in oil is that in cutting the steam flow, temperature and pressure of the light oils is only slightly changed so volatilization should continue at about the same rate and the amount of oil condensate should remain the same. However, as considerably less steam is used, the water condensate should be materially decreased. Our 100 cc sample will therefore show a higher percentage of oil if purging is not complete.

When the check sample again shows 5 per cent or less oil, the steaming rate is again decreased. This procedure is continued until a point is reached when steam can no longer volatilize 5 per cent or more oil. As stated before, air at atmospheric temperatures can certainly not volatilize that oil either.

The use of steam as a purging agent can be recommended where the higher temperatures are necessary or are not objectionable.

It should not be used in cast iron mains or long pipe lines, complicated headers, boosters or machines with close clearances. The effect of its higher temperatures with the resultant expansion should be carefully considered. Also large holders or apparatus with large condensing surfaces are poor subjects for steam purging.

In general, steam is good purging agent for the following reasons:

1. Distillation of vapor phase oils.
2. Wash down due to condensate.
3. It is usually available in large quantity.

It is not a good purging agent because:

1. It is difficult to determine the end point.
2. High temperature with resultant expansion may cause strains or flange leaks.
3. Condensation is high on large vessels requiring an excessive amount.

In a previous paragraph of this section it was stated that the only accurate method of determining explosive limits of mixed gases was laboratory burning determinations. However, when the chemical analysis of a mixed gas is known both the upper and lower explosive limits may be calculated. Experiments conducted by U. S. Bureau of Mines with simple limit gas mixtures showed that calculated values checked fairly close with observed data, but that complex mixtures varied up to 5 per cent. It was also difficult to repeat an experiment and arrive at the same results. The obvious conclusion, therefore, is that the point at which a gas mixture is non-inflammable will vary over 5 per cent of the calculated lower limit range and to be on the safe side it is better to over-purge than to under-purge.

Attention is called to the fact that no mention has been made of purging by allowing a combustible gas to force air out of a new gas line, a method commonly called air purging. This method should be discouraged because it is impossible to go from air to gas or gas to air without the mixture passing through both the upper and lower inflammable limits with the resulting explosive hazard.

Gas accumulations in buildings, due to leaks or broken lines, can be exceedingly dangerous. Several bad explosions have resulted from this cause in recent years. In cases of light gases containing a considerable amount of hydrogen the gas collects near the roof of the building and cannot be detected at the floor level. When a gas accumulation is known to exist in a building, care should be taken to prevent any ignition taking place, even from the floor levels, all people should be removed from the building and sufficient time allowed for the building to clear by means of natural draft.

## *Symposium* DISCUSSION

(*Continued from page 80*)

air-natural gas mixture is added to the boosted coke oven gas or in another case, it was, as I understood it, added on the inlet side of the gas booster.

I would like to ask what operating difficulties are encountered when you start mixing air or blast furnace gas along with the mixture of coke gas and natural gas.

**R. I. Gumaer:** We are using some natural gas to make up a shortage of coke gas while certain of our ovens are being repaired. It was thought that we could get far better use of this gas if we would mix blast furnace gas with it to stabilize its Btu.

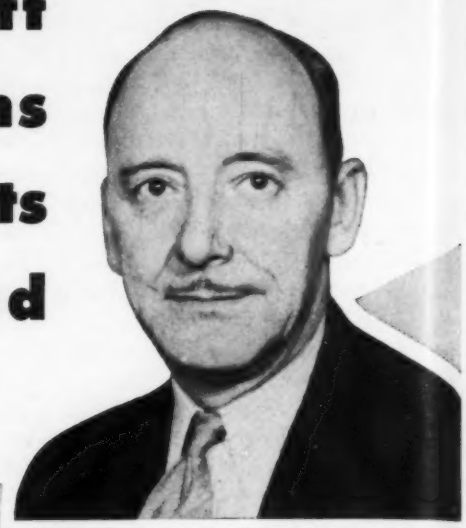
We have so far been unable to get a good burning mixture using any mixture of natural gas and blast furnace gas. We are trying to burn this misture on the end of open pipes such as would be used for drying ladles, runners, hot tops, etc. Has anyone had similar experience in using a mixture of natural gas and blast furnace gas? I believe Mr. Helm stated that he had used that mixture.

**H. B. Helm:** As far as the mixing station is concerned, we have had little or no difficulty with it. It is oil operated and so designed that should the oil pressure fail, all the equipment remains in that position, the butterflies neither open nor close. Should this occur it is only necessary for the gas dispatcher to call the by-product operator who goes to the mixing station and shuts it down until it can be repaired.

As far as the mills are concerned, the natural gas-blast furnace gas mixture is introduced before the boosters. The amount of this make-up fuel being, at peak demand, only 10 per cent of the total mixed gas, there is little or no effect on the mills. Even our welding furnaces, both continuous butt welding furnaces and lap welding furnaces, do not complain about the Btu variation in it.

In view of the fact that the quantity of make-up fuel is so small in proportion to the total mixed gas, the Btu does not vary greatly, running from 550 when we are burning straight coke gas up to about 590. We have run into no difficulty. Some years ago when we were diluting coke gas with blast furnace gas, we did run into difficulty on our welding furnaces and had to add natural gas at each furnace, but we no longer use that system.

# "Electrical Surges at Shift Change Caused Shutdowns On Our War Loaded Circuits —But BUSS Fuses Cured Our Trouble."



**Mr. V. R. LUNDQUIST,** ***Plant Engineer***
**The Benrus Watch Company**
**Waterbury, Connecticut**

"Ours was a typical plant expanding rapidly due to increased production for war," Mr. Lundquist explained. "All of our lines were loaded to near capacity. Then trouble started. Fuses in branch circuits were blowing as often as 5 or 6 times a week at shift changes. The sudden surges created in the lines when a battery of machines started simultaneously caused ordinary fuses to blow. Then, of course, the machines shut down and irreplaceable production time was lost.

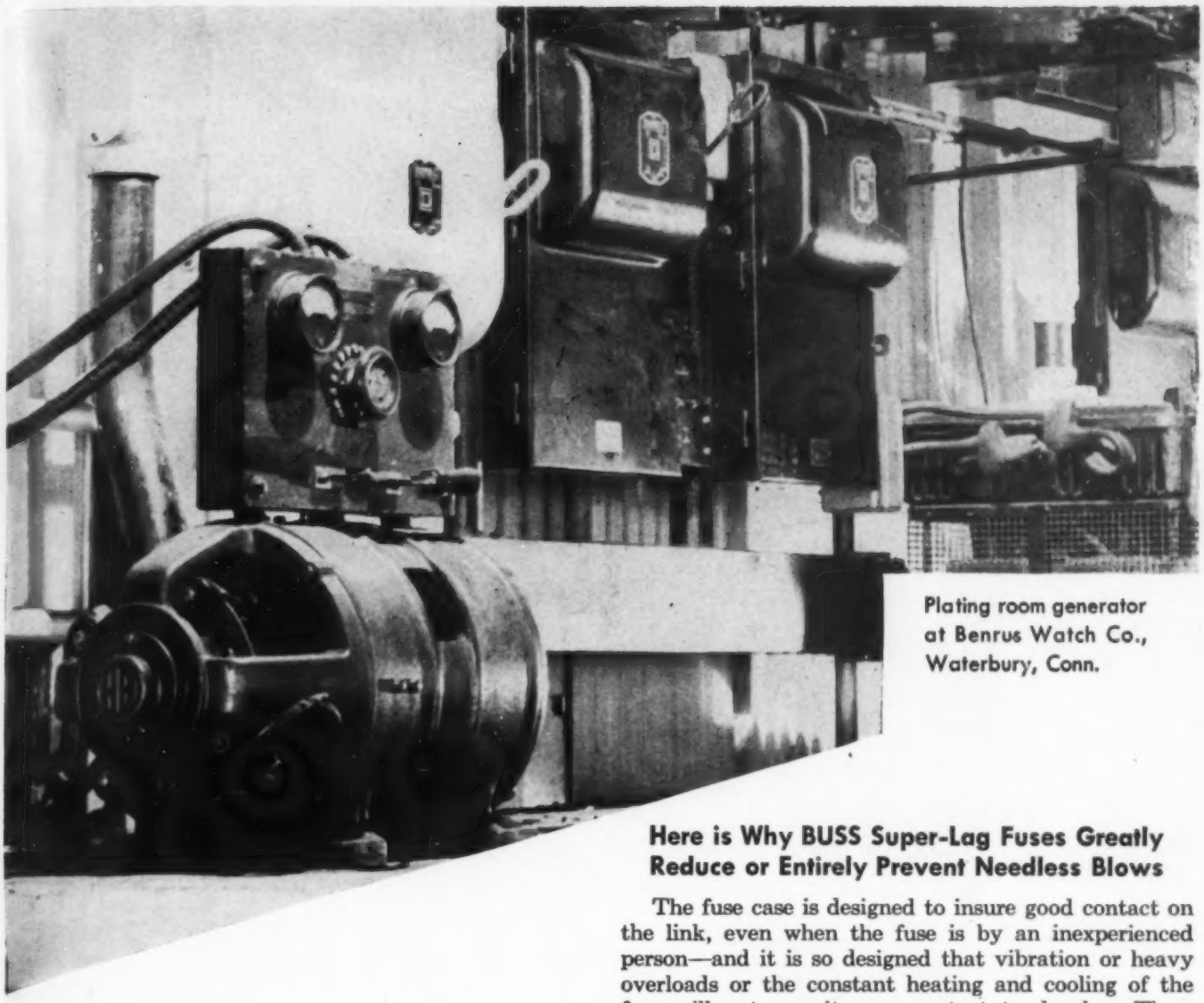
"About January, 1942, we installed Buss Super-Lag fuses in all circuits. The trouble was corrected immediately, and we have experienced no recurrence of this costly nuisance.

***Why* BUSS Fuses Don't Blow Needlessly**

**10 FEATURES** in the design of the FUSE-CASE help make it possibe

*and* **The SUPER-LAG** development in the FUSE-LINK completes the job.

**BUSS**



Plating room generator at Benrus Watch Co., Waterbury, Conn.

## *You, too,* CAN PROFIT BY STANDARDIZING ON BUSS FUSES

Mr. Lundquist's experience that led him to specify BUSS fuses at Benrus Watch Company is a typical reaction of men who have tried these fuses. It is proof that shutdowns caused by needless blows can be prevented—and adequate protection can be provided in the same protective device.

As for BUSS Super-Lag fuses—the experience of thousands of plants throughout all industry has proven time and again that by using them you can obtain trouble-free protection at a lower overall cost than with any other renewable fuse.

They require no maintenance or periodic inspection. They don't open needlessly. If one opens you know there is some fault that needs correction.

### Here is Why BUSS Super-Lag Fuses Greatly Reduce or Entirely Prevent Needless Blows

The fuse case is designed to insure good contact on the link, even when the fuse is by an inexperienced person—and it is so designed that vibration or heavy overloads or the constant heating and cooling of the fuse will not permit poor contact to develop. Thus, excessive heat which causes fuses to blow when they should not is prevented.

The fuse link used is the famous "BUSS SUPER-LAG." It has lag-plates attached which give it a long time-lag so that unusually heavy starting currents or other harmless overloads will not cause the fuse to blow.

### And Here is How to Solve the "Shutdown Problem" in Your Own Plant

Pass the word along that all purchase records dealing with circuit protective devices should be immediately changed to call for BUSS Super-Lag Renewable fuses. Then, as fuses are replaced or new installations made, your plant will automatically get the benefit of the carefree, trouble-proof protection that BUSS Super-Lag fuses give.

BUSSMANN MANUFACTURING CO.
University at Jefferson, St. Louis 7, Missouri
*Division McGraw Electric Company*

## *Super-Lag* FUSES SOLD THROUGH WHOLESALERS

Best evidence of the ability of Reliance Motors to deliver the goods under difficult operating conditions is the number of these sturdy motors at work on extra tough jobs in many industries.

Reliance fully-enclosed and splash-proof motors are standing up and giving fully satisfactory service in the midst of acid fumes, heavy moisture, splashing and falling liquids and other trying situations where a less well protected motor would soon fail.

It's a good rule to talk over motor problems of this or any other kind with a Reliance Application Engineer. He has a lot of specialized experience and will be glad to help you all he can.

**RELIANCE A-C D-C MOTORS**

**RELIANCE ELECTRIC & ENGINEERING CO.**

**1084 IVANHOE ROAD • CLEVELAND 10, OHIO**

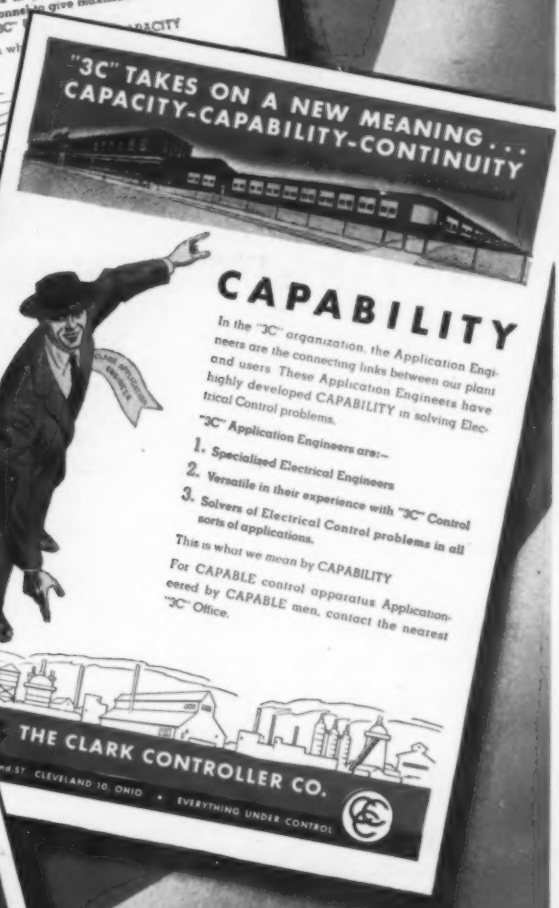
Birmingham • Boston • Buffalo • Chicago • Cincinnati • Detroit • Greenville (S.C.) • Houston • Kalamazoo • Los Angeles • Minneapolis
New York • Philadelphia • Pittsburgh • Portland (Ore.) • St. Louis • San Francisco • Syracuse • Washington, D. C. • other principal cities

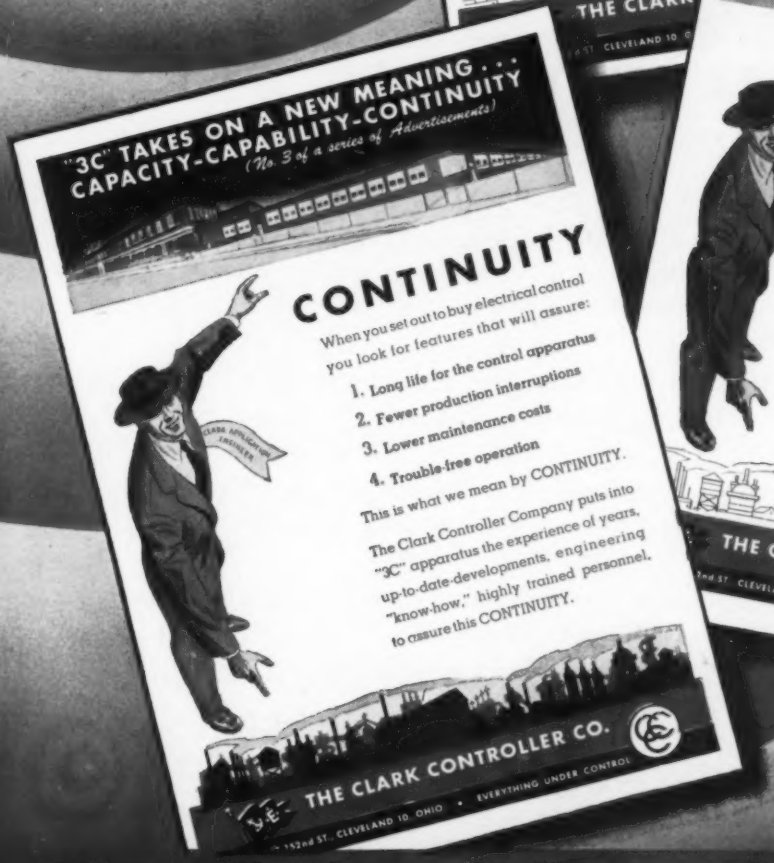
**"MOTOR-DRIVE IS MORE THAN POWER"**

# "3C" TAKES ON A NEW MEANING

*This is No. 4 in a series of four advertisements that illustrate the combined advantages of buying "3C" Electrical Control Apparatus.*

"3C" TAKES ON A NEW MEANING . . .
CAPACITY-CAPABILITY-CONTINUITY
CAPACITY
The newly expanded Clark Controller Company plant appears as shown in the above picture. Approximately three acres under one roof permits combining personnel and equipment from our other plants in one central location.
Additional machinery and equipment being installed will facilitate production of all types of "3C" Electrical Control apparatus.
This new CAPACITY means more to us than mere added space. It means a co-ordinated capacity to:
1. Develop new apparatus
2. Improve existing devices
3. Increase Commercial and Application Engineering Service
4. Utilize in general our trained, experienced personnel to give maximum service to users of "3C"
THE CLARK


"3C" TAKES ON A NEW MEANING . . .
CAPACITY-CAPABILITY-CONTINUITY
CAPABILITY
In the "3C" organization, the Application Engineers are the connecting links between our plant and users. These Application Engineers have highly developed CAPABILITY in solving Electrical Control problems.
"3C" Application Engineers are:—
1. Specialized Electrical Engineers
2. Versatile in their experience with "3C" Control
3. Solvers of Electrical Control problems in all sorts of applications.
This is what we mean by CAPABILITY
For CAPABLE control apparatus Applicationeered by CAPABLE men, contact the nearest "3C" Office.
THE CLARK CONTROLLER CO.
EVERYTHING UNDER CONTROL


"3C" TAKES ON A NEW MEANING . . .
CAPACITY-CAPABILITY-CONTINUITY
(No. 3 of a series of Advertisements)
CONTINUITY
When you set out to buy electrical control you look for features that will assure:
1. Long life for the control apparatus
2. Fewer production interruptions
3. Lower maintenance costs
4. Trouble-free operation
This is what we mean by CONTINUITY.
The Clark Controller Company puts into "3C" apparatus the experience of years, up-to-date-developments, engineering "know-how," highly trained personnel, to assure this CONTINUITY.
THE CLARK CONTROLLER CO.
EVERYTHING UNDER CONTROL

THE CLARK CONTROLLER CO.

1146 EAST 152nd ST., CLEVELAND 10, OHIO • EVERYTHING UNDER CONTROL

# P-G Limit Switch *Resistors* . . . . . .

*for use with . . .*

## CRANE HOIST SAFETY LIMIT STOPS!

P-G Limit Switch Resistors are available for use with any crane hoist safety limit switch operating on direct current from 5 HP to 200 HP.

Design of the P-G Resistance Grid is ideal for safety limit stop operation because it produces a resistor element of sufficient mechanical strength to withstand the brief but heavy overloads peculiar to this service.

Constructed from the same basic parts used for P-G Standard Unit Resistors, long trouble-free service is assured without worry over vibration, moisture or corrosive fumes.

Standard enclosures as illustrated give ample protection from ordinary outside mechanical damage with no sacrifice of ventilation so necessary for dissipation of heat.

Try a P-G Limit Switch Resistor on your next application, particularly, if service conditions are severe.

Detailed information in BULLETIN No. 500

*Copy on request*

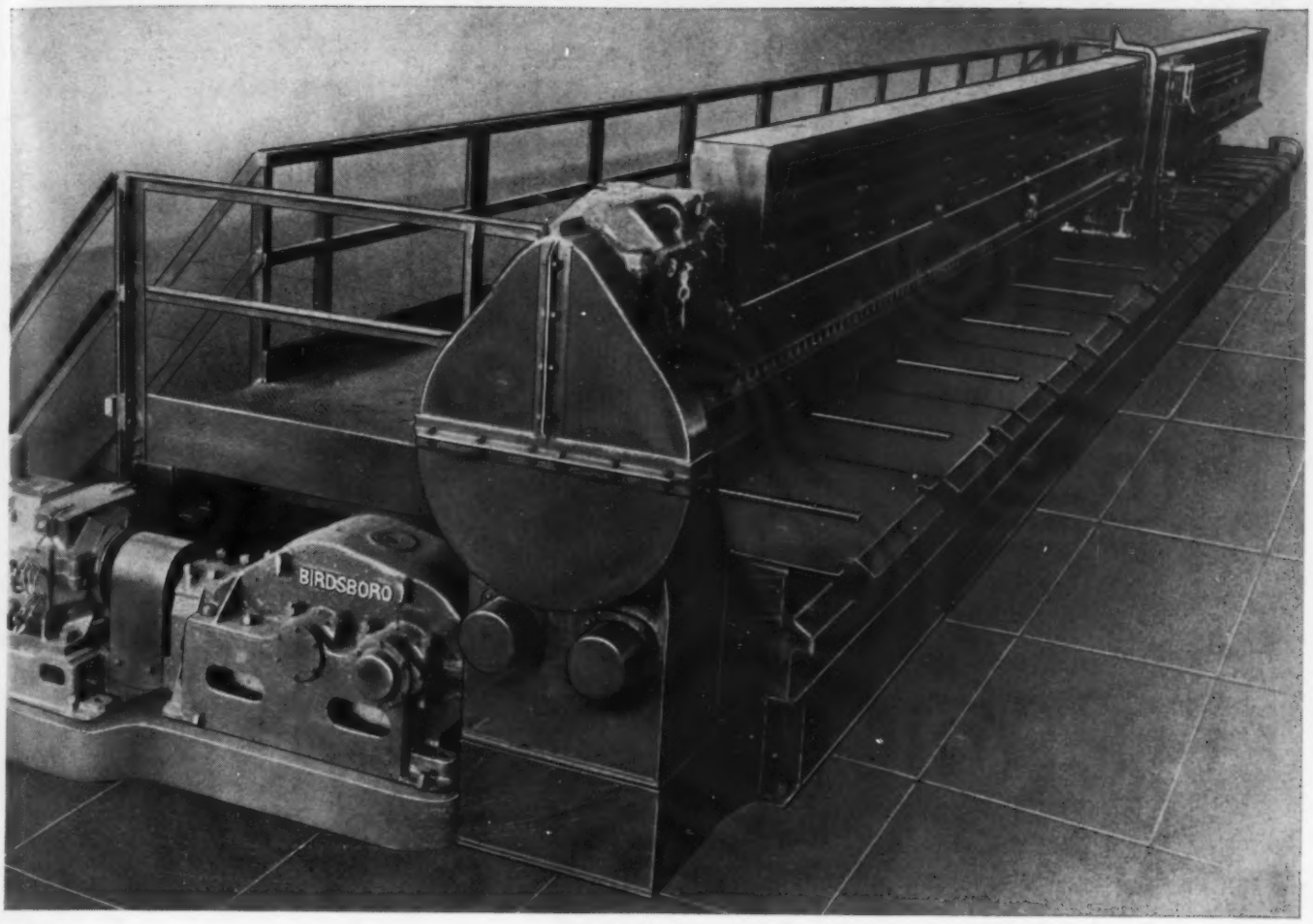
P-G

*The Nonbreakable Steel Grid Resistor*

**THE POST-GLOVER ELECTRIC COMPANY**

• ESTABLISHED 1892 •

221 WEST THIRD STREET, CINCINNATI 2, OHIO




## For *Quick Gauging* of 5" Squares and Rounds

## New Birdsboro Saw Gauge Table

This Birdsboro saw gauge table serves a cold saw and is used for gauging material up to 5" round and square and equivalent sections coming from the hot bed. The table is furnished with a motor-operated gauge and push-off mechanism for transferring material to the cradles.

Of latest design, the Birdsboro saw gauge table includes bearings of anti-friction type with an automatic centralized lubrication system. Gauge as shown is power-operated, both lift and gauge travel, and arranged for remote control. Gauge head has capacity to gauge up to 60' in length.

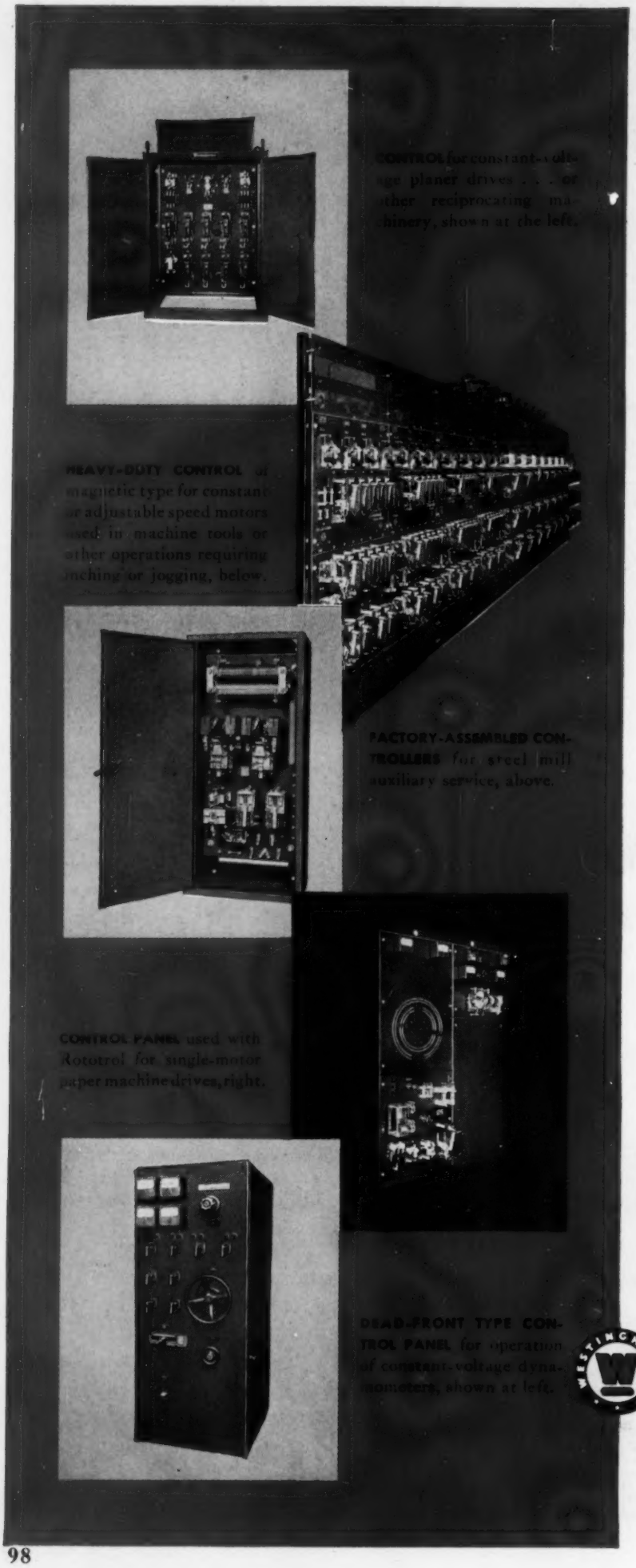
Birdsboro specializes in making all types of steel mill equipment to meet your specific requirements. You'll find it pays to consult Birdsboro. Write us today.

BUY WAR BONDS

BIRDSBORO STEEL FOUNDRY AND MACHINE COMPANY, BIRDSBORO, PA.

**BIRDSBORO**

**STEEL MILL EQUIPMENT**



CONTROL for constant-voltage planer drives . . . or other reciprocating machinery, shown at the left.

HEAVY-DUTY CONTROL of magnetic type for constant or adjustable speed motors used in machine tools or other operations requiring inching or jogging, below.

FACTORY-ASSEMBLED CONTROLLERS for steel mill auxiliary service, above.

CONTROL PANEL used with Rototrol for single-motor paper machine drives, right.

DEAD-FRONT TYPE CONTROL PANEL for operation of constant-voltage dynamometers, shown at left.

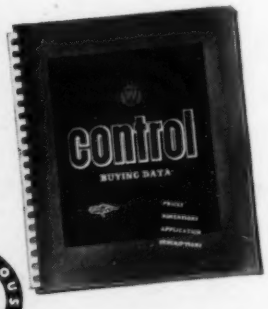
# For any D-C Control

## A MOTOR STARTER OR COMPLETE MILL CONTROL

# Check Westinghouse

You may never need these specialized controllers shown on this page—for cranes, planers or paper machines—but the same excellence in engineering, design and manufacture goes into every Westinghouse control device. Should your particular problem require special help, call a Westinghouse engineer to review your requirements and make the necessary recommendations.

Westinghouse motor control covers the entire range of standard a-c and d-c controls and accessories for every type of drive, plus many specialized types of control shown here. For help on any control problem, it pays to first call Westinghouse. Or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pa. J-60608



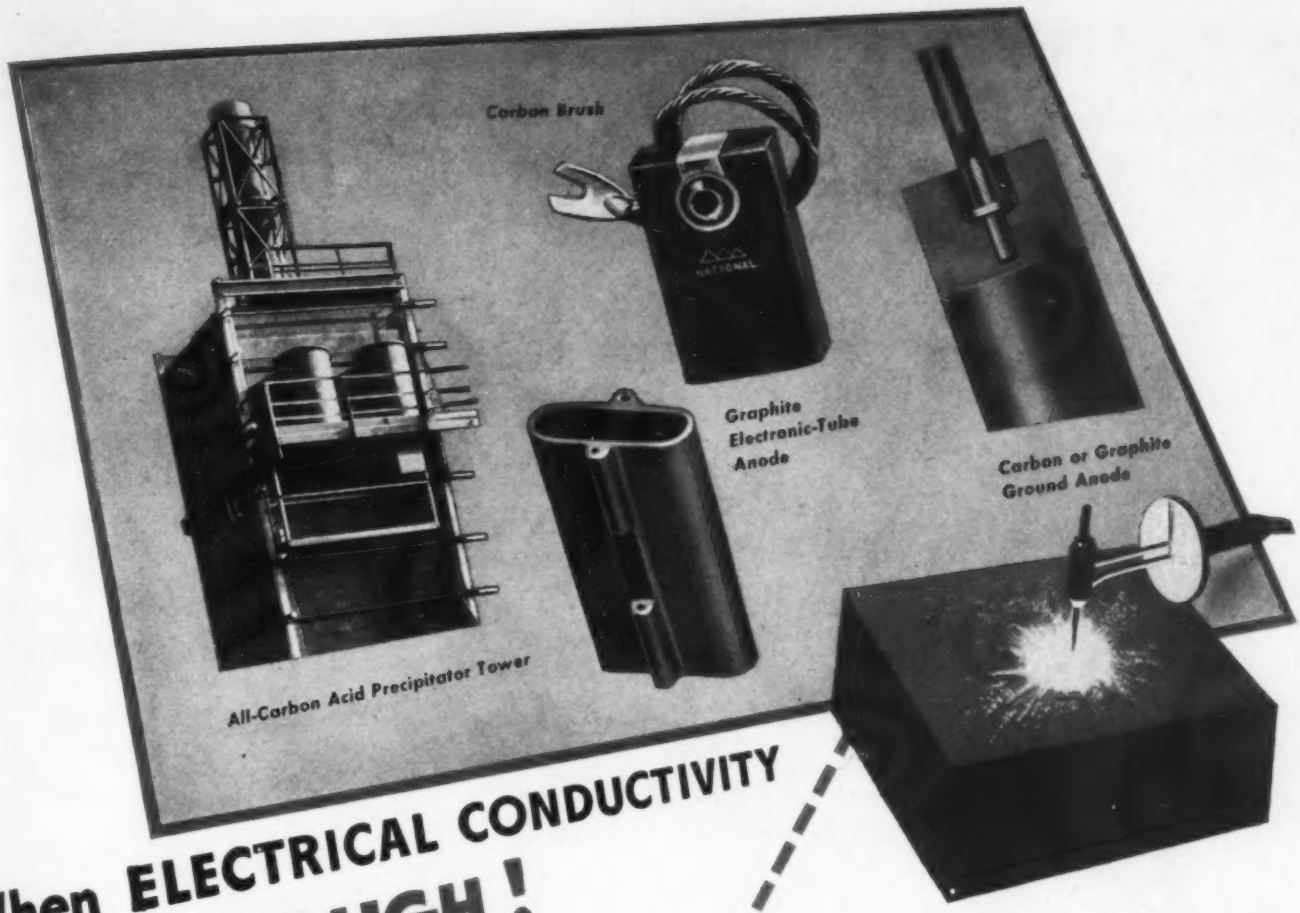

**Send for this booklet**

The entire range of Westinghouse standard motor control is covered in this 290-page Buying Data Book. If you do not have a copy, phone your Westinghouse office for Catalog No. 7000.

**Westinghouse**

PLANTS IN 25 CITIES . . . OFFICES EVERYWHERE

**Motor Control**




# When ELECTRICAL CONDUCTIVITY Isn't ENOUGH!

BESIDES electrical conductivity, each of these devices must have certain other properties . . . in combinations found only in carbon or graphite!

Because of these properties, the 46-foot carbon precipitator withstands acids and thermal shock. The mechanically strong carbon brush minimizes arcing and operates at lower friction than other materials. The graphite electronic tube anode dissipates heat, retains its shape and is inert. And the ground anode resists chemical and electrolytic action in the cathodic protection of metal structures.

"National" carbon and graphite can be supplied in grades running from porous to impervious . . . widely known in the latter form as "Karbate" materials and products.

We've specialized for 60 years in manufacturing many grades of carbon and graphite and applying their singular properties to the solution of industrial problems. For more information write for our Catalog Section M-8000-A.

**BAR OF WHAT?**
Carbon, Graphite or "Karbate" materials of course!

The registered trade-marks "National" and "Karbate" distinguish products of National Carbon Company, Inc.

**NATIONAL CARBON COMPANY, INC.**
*Unit of Union Carbide and Carbon Corporation*
UCC
*General Offices:* 30 East 42nd Street, New York 17, N. Y.
*Division Sales Offices:* Atlanta, Chicago, Dallas, Kansas City, New York, Pittsburgh, San Francisco

LET'S GET THE JAP — AND GET IT OVER!

# COLD-ROLL FORMED ON A YODER

## REMEMBER ANY OF THESE FORMS?

● They are a few of the thousands of special shapes once widely used in making automobiles, accessories, bicycles, electrical fixtures and equipment, toys, household appliances, structural components, radios, refrigerators, air conditioning equipment and other everyday items that make up the normal industrial output of the nation. Like thousands of war specialties now occupying most of industry's time . . .

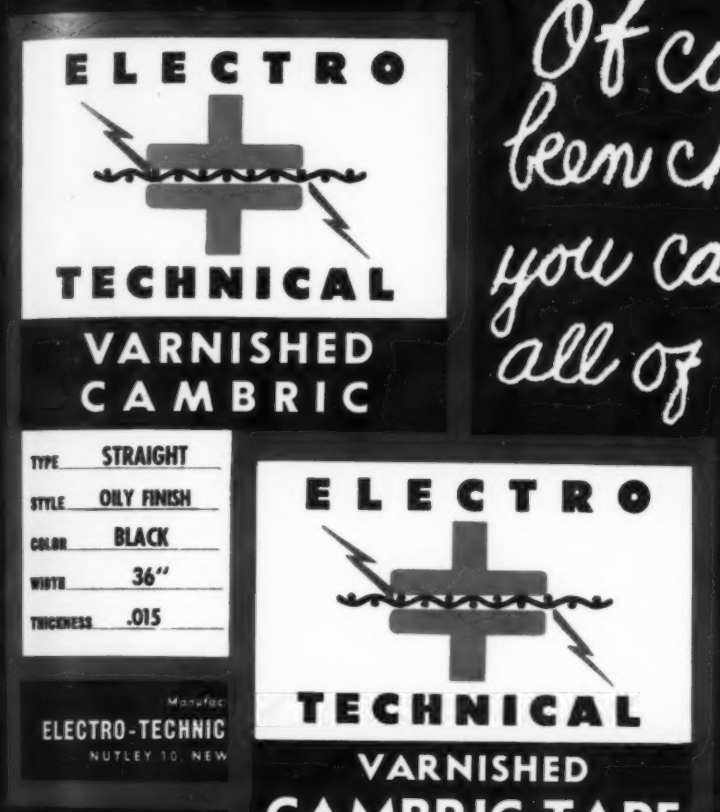
THEY ARE ALL ROLL FORMED ON YODER MACHINES.

If you do not know about the application of Yoder High Production Working Machinery to your product, write today for full information.

**THE YODER COMPANY**
5526 WALWORTH AVE., CLEVELAND 2, OHIO

METAL • WORKING • PRODUCTION • MACHINERY
ENGINEERING
YODER
MANUFACTURING

Andy - have your winding data sheets been checked lately?




Of course they have been checked Jim - and you can be assured that all of them specify Electro-Technical Varnished Cambric and Tapes!"

"Those attractive package labels are my guides to the right kind of insulation for my re-wind jobs."

Andy.



Copyright Electro-Technical Products, Inc., 1945

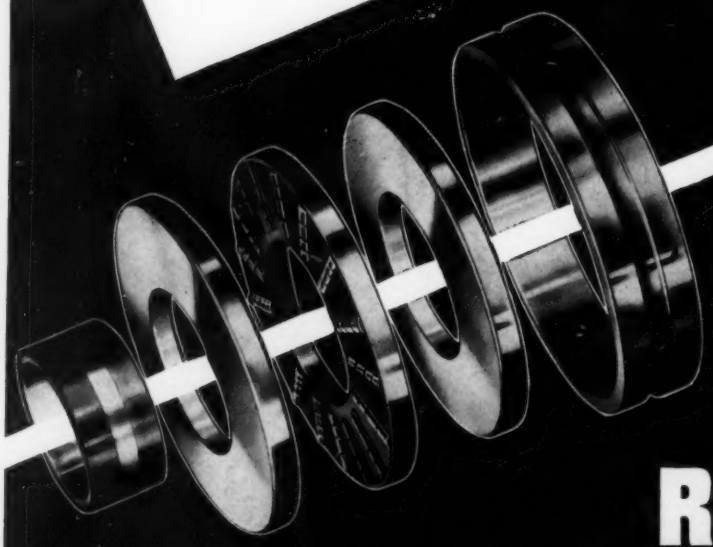
# Choose Right-Angle Loading for Outstanding Performance . . .

● In many applications—particularly in heavy-duty service—Rollway Solid Cylindrical Roller Bearings outlast and outperform other types of bearings. There's more metal to carry the load . . . long line contact with the race . . . and lower unit pressures. A combination that affords from 3 to 5 times the carrying capacity of equal-sized ball bearings.

But that's only half of the story. Rollway Right-Angle Loading splits compound loads into the two simple components of *pure radial* and *pure thrust*—each of which is carried on a separate set of rollers. Total load magnitudes per bearing are lower, and are carried perpendicular to the roller axis. There are no oblique resultants, no complicated stresses. Stress analysis and bearing computations are simpler *and more exact.*

**ROLLWAY BEARING CO., INC.**
**Syracuse, N. Y.**

ROLLWAY RIGHT-ANGLE LOADING



● If you haven't a ROLLWAY BEARING CATALOG in your engineering file, write for one today. And ask our engineering specialists to help you in selection of the type and series best suited for your application. Just send a print of your assembly with specification of load, speed and type of service for confidential analysis. No charge. No obligation.

# ROLLWAY
## CYLINDRICAL ROLLER BEARINGS

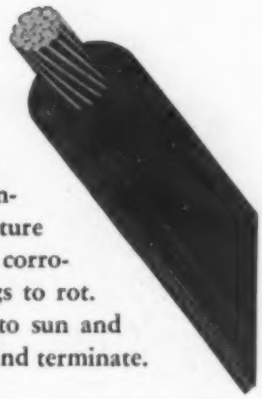
SALES OFFICES: Philadelphia • Boston • Pittsburgh • Youngstown • Cleveland • Detroit • Chicago • St. Paul • Houston • Tulsa • Los Angeles

# 4 OF MANY CABLES

## engineered by

# OKONITE

## OKOLITE-OKOPRENE



Versatile, low in maintenance cost, Okolite-Okoprene* is designed for service up to 5,000 volts, for control wiring, lighting and power circuits. Its Okolite oil-base insulation has excellent electrical properties. Its outer protective jacket of non-flammable Okoprene resists moisture and oil as well as abrasion and corrosion. Contains no fibrous coverings to rot. May be buried in earth, exposed to sun and elements. Simple to handle, splice and terminate.

*Patent No. 2,312,058

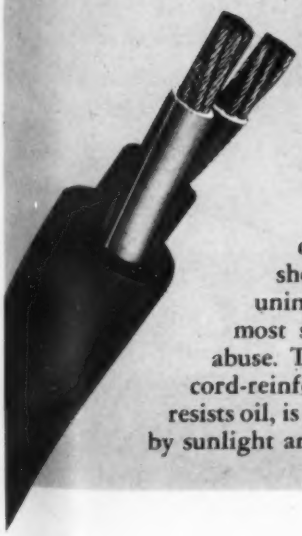
## OKOLITE-OKOPRENE
### for high voltages

Okolite-Okoprene high voltage cables are supplied for service up to 35,000 volts a. c.—110,000 volts d. c. with protective shielding as conditions demand. Hundreds of thousands of feet of Okolite-insulated high voltage cables for generator leads, high voltage feeders to motors, transformer leads, submarine cables and other power circuits have proved their efficiency under all kinds of operating conditions.

## VARNISHED CAMBRIC

Okonite varnished cambric insulated wires and cables for operations up to 28,000 volts comprise a complete line for all types of power circuits. A wide range of outer protective coverings is available. These outer coverings include fibrous sheaths, lead sheaths, interlocked metallic tape and armor wire, asbestos braid, and flame retardant cotton braid as well as Okoprene and other non-metallic synthetic sheaths.

## OKOCORD PORTABLE CABLES



Extra flexible stranding is standard in all Okocord portable cords and cables designed for leads on electrical welding equipment, tools, portable equipment, magnet cranes, dredges and electric shovels. Designed to transmit uninterrupted power under the most severe conditions of external abuse. This cable is furnished with a cord-reinforced Okoprene jacket that resists oil, is non-flammable and unaffected by sunlight and exposure.

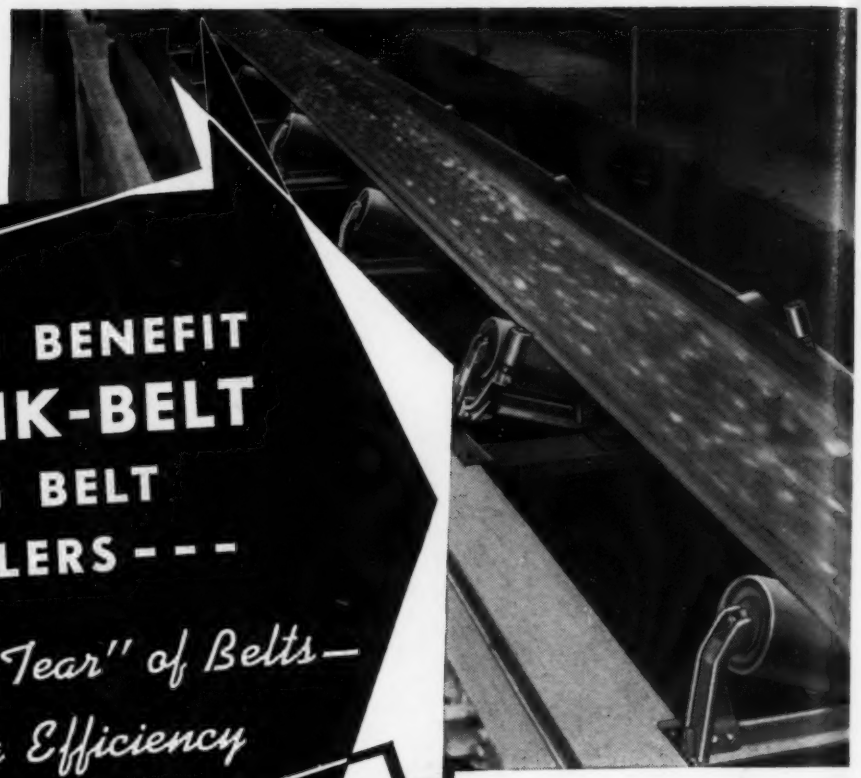
Engineers in all branches of industry are invited to bring their problems of electrical transmission and distribution to Okonite engineers. By combining their experiences, the correct selection of wires and cables is made easy, low maintenance and long life assured. The Okonite Company, Passaic, New Jersey.

# OKONITE

OKONITE SINCE 1878

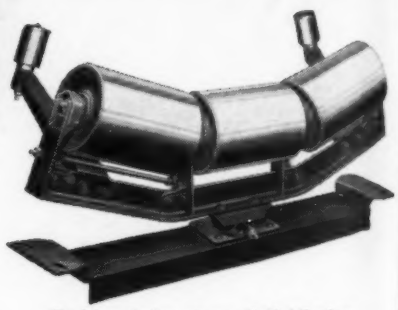
**insulated wires and cables**

4182



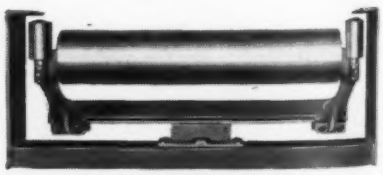
# HOW YOU BENEFIT BY USING LINK-BELT SELF-ALIGNING BELT CONVEYOR IDLERS - - -

*Reduce "Wear-and-Tear" of Belts— Increase Operating Efficiency*



Positive-Action type Self-Aligning Idler for one-direction belt travel.

Counterweighted-Disc type Self-Aligning Idler for reversing belt travel.



Positive-Action Self-Aligning Return Idler.

● Any slight misalignment of conveyor belts, resulting from off-center loading, strong side winds, unequal belt stretch, improper splicing, or material building up on the idler rolls, causes the Link-Belt positive-action type self-aligning idler to automatically contact an actuating roll. This swings the pivoted idler into a skewed position, thus gently but positively returning the belt to its proper running position on the conveyor idler roadbed. Actuating rolls yield easily and recede quickly from the belt so that the period of contact is short and without hard or continuous pressure which might injure the belt edges.

Link-Belt self-aligning idlers are made in two types, selection depending upon whether the belt travels in one direction only, or whether the belt conveyor is reversing.

Link-Belt makes all kinds of conveyors. Link-Belt Engineers have broad experience in the design, manufacture and application of conveying, materials handling and power transmission machinery, and can give you an impartial recommendation. Call or write the nearest office.

**LINK-BELT COMPANY** 9093-A

Chicago 9, Indianapolis 6, Philadelphia 40, Atlanta, Dallas 1, Minneapolis 5, San Francisco 24, Toronto 8, Pittsburgh 19, Cleveland 13, Detroit 4, New York 7. Other Offices in Principal Cities.

**OTHER LINK-BELT PRODUCTS INCLUDE:**

Conveyors and Elevators of all types — Belt, Apron, Pan, Bucket, Chain, Bulk-Flo, Flight, Oscillating-Trough Screw, Sidekar-Karrier, etc. . . . Feeders . . . Vibrating Screens . . . Skip Hoists . . . Silent, Roller, Malleable Iron, Promal and Steel Chain Drives . . . Speed Reducers and Increasers . . . P.I.V. Gear Variable Speed Changers . . . Gears . . . Clutches . . . Couplings . . . Base Plates . . . Take-ups . . . Babbitted, Ball and Roller Bearings . . . Grease Cups . . . Safety Collars . . . Shafting, etc. — everything from one source to make your materials handling and power transmission machinery operate at peak efficiency. Send for Catalogs.

**LINK-BELT**

**BELT CONVEYOR EQUIPMENT**

IDLERS • TRIPPERS • BELTS • PULLEYS • BEARINGS • DRIVES

# *Developed* A NEW STANDARD IN SAFETY!

## THE ROWAN 900-KBF COMBINATION, OIL IMMERSED, REDUCED VOLTAGE, IMPEDANCE TYPE AC MOTOR STARTER

This up-to-the-minute starter is a *combination* of our reduced voltage impedance starter and oil immersed safety disconnect switch with Rowan Air-Seal Fuses and Seal-Off Compartment for line, motor and control leads. Combining these Rowan advancements into one single unit conserves installation space and costs. *Maximum Safety is provided by mechanically interlocking the operating mechanism of the Safety Disconnect Switch with the Oil Tank.*

Reduced starting voltage is obtained by the use of continuous-wound coils with mechanical adjustment for varying the impressed voltage thereby eliminating tap failures.

The time of acceleration is determined by the motor and its connected load. There is no disconnecting of the motor from the line at any period during acceleration. This assures a minimum of line disturbance.

**For safety, smooth acceleration, continuity of service and low overall cost—This ROWAN Type 900-KBF Combination Reduced Voltage Starter "Tops them all." Complete detailed information sent on request.**

## ADDED FEATURES THAT CONTRIBUTE TO SAFETY, LOW INSTALLATION COSTS AND CONTINUITY OF SERVICE

1. **Safety disconnect switch is completely interlocked with the oil tank in raised or lowered position—positive line disconnection.**
2. **Magnetic overload relays, combination of inverse time element, instantaneous operation—automatic Reset.**
3. **Rowan Air-Seal Fuses—A proven short circuit protection.**
4. **Fully automatic—Push-Button Operated.**
5. **Oil immersed for maximum safety and protection.**
6. **Enclosure is of dust-tight construction.**
7. **Seal-off Terminal Compartment arranged for top and bottom conduit connections.**

*More than a generation devoted to the design and manufacture of Oil Immersed AC Motor Controls.*

**ROWAN CONTROL**

THE ROWAN CONTROLLER CO., BALTIMORE, MD.

# Matched Performance of brushes MAKES MOTORS BEHAVE

SPEER

To get the most work out of d-c and slip-ring motors and generators, equip them with SPEER Carbon Brushes. They make motors BE-HAVE, because every SPEER brush is *matched* — mechanically and electrically — to the service characteristics of the machine it's sold to serve.

More and more motor users are turning to SPEER brushes for utmost freedom from burning, overheating, sparking, excessive wear, energy losses, and other brush troubles that decrease operating efficiency, cause extra maintenance.

You have *double* assurance of matched performance from SPEER brushes. First, because SPEER has made a specialty of matching brushes to machines for nearly 50 years. And second, because in SPEER'S all-inclusive line of standard and special carbon, graphite, electro-graphite and metal-graphite brushes, there is the grade that will deliver peak performance, fewer brush renewals and less maintenance on any application.

For SPEER brushes matched to the performance of *your* motors, see your supply house or electrical contractor — or write direct for Brush Data Forms.

CHICAGO • CLEVELAND • DETROIT
MILWAUKEE • NEW YORK • PITTSBURGH

SPEER
CARBON COMPANY
ST. MARY'S, PA.

8002

# How BAILEY CONTROLS Improve Power Service

## IN YOUR PLANT

There may be opportunities for the improvement of power service as well as for increasing safety, saving fuel and reducing maintenance by the proper application of Bailey Controls. Get the recommendation of your local Bailey Engineer or write for Bulletin 15-C describing Bailey Controls for Steam Plants. Bailey Meter Company, 1047 Ivanhoe Road, Cleveland 10, Ohio. In Canada—Bailey Meter Company Limited, Montreal.

A-94

## CONTINUITY

Fewer outages of boilers and prime movers improve continuity of power service.

## CAPACITY

In addition to increasing steam generating capacity Bailey Controls also increase output and efficiency of prime movers by supplying steam at design conditions.

## HEAVY LOAD SWINGS

Simultaneous regulation at all points of control accurately and safely takes the boiler through heavy load swings.

## PROCESS STEAM

Steam at correct pressures and temperatures for process operation is furnished by combustion and steam temperature controls. Pressure reducing and desuperheating control systems insure adequate low pressure steam. Combustion control usually does away with the need for a steam accumulator.

**BAILEY METER COMPANY**

1047 IVANHOE ROAD · · · CLEVELAND 10, OHIO

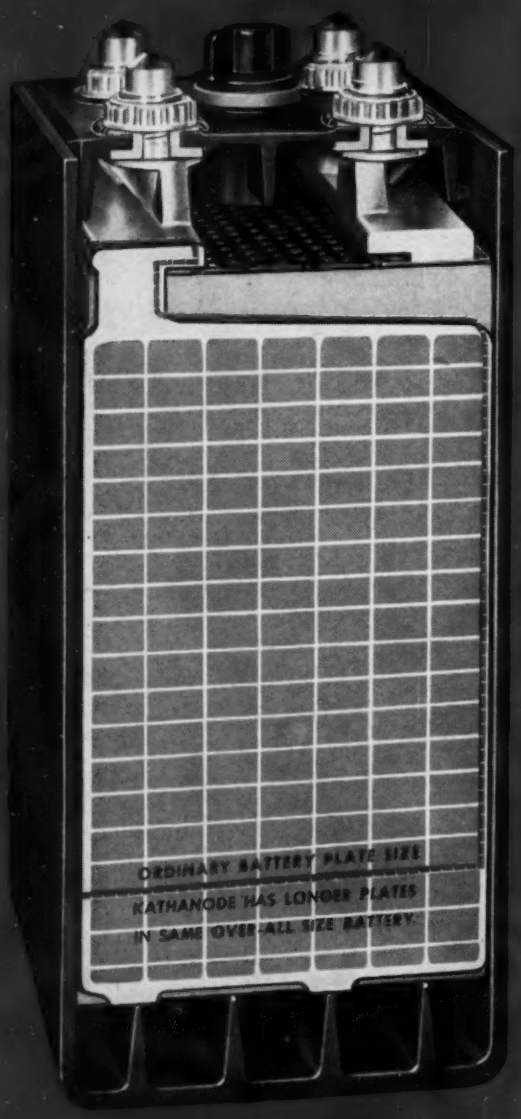
*Controls for Steam Plants*

COMBUSTION • PRESSURE
FEED WATER • LIQUID LEVEL
TEMPERATURE • FEED PUMPS

# KATHANODE

## HAS MORE WORKING *Active Material*

**To give your ELECTRIC TRUCK BATTERY 100% CAPACITY PERFORMANCE throughout its life!**



Your industrial truck will do more work, *longer,* if Kathanode equipped.

The Kathanode design reduces sedimentation, permits shallower sediment wells, making possible a longer plate, thus exposing more active material to the action of the electrolyte. With Kathanode, therefore, your work cycle is less severe on the power-producing active material. This provides a minimum of wear, maximum speed of operation and 100% sustained capacity throughout service life.

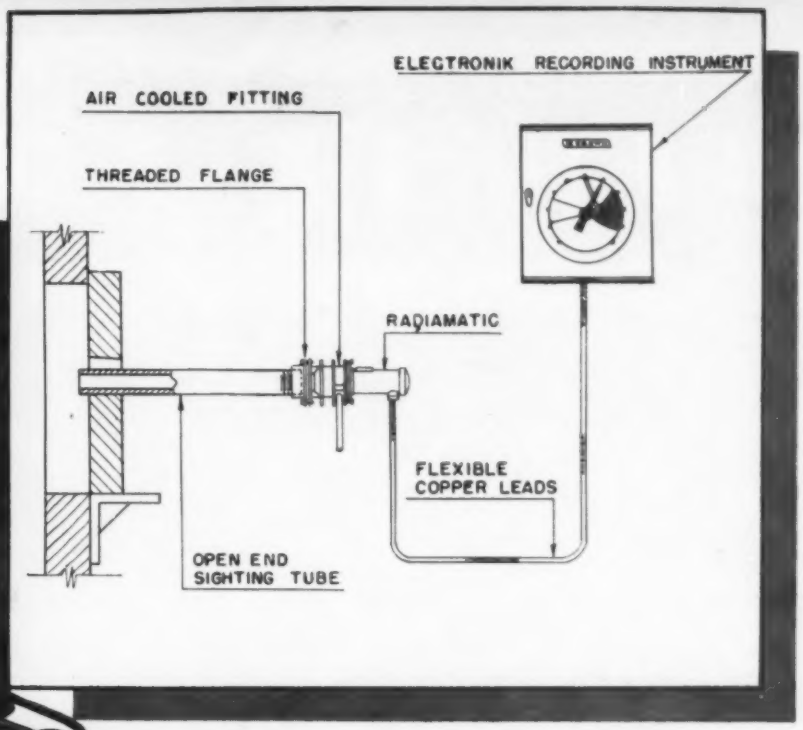
Kathanode is a proved design from twenty years of actual field service in materials handling electric industrial trucks.

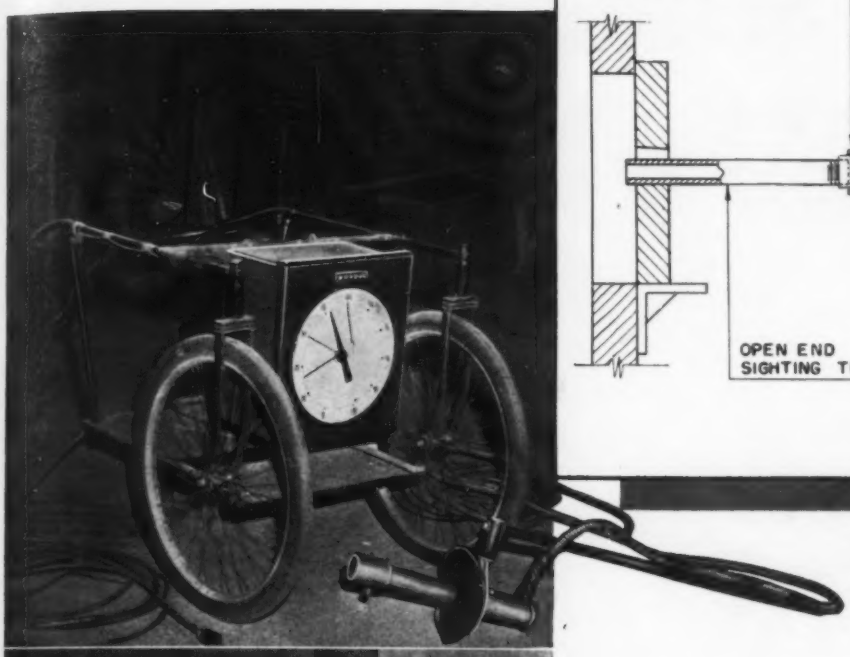
In industrial trucks battery power is best and Kathanode has proved itself the best battery power. Write Dept. 48 for Catalog 100 on Kathanode Glassklad Batteries for Industrial Truck and Tractor Service.

# GOULD

PIONEER OF GLASSKLAD CONSTRUCTION

GOULD STORAGE BATTERY CORPORATION



(Upper) Brown ElectroniK Potentiometer, with Radiamatic sighting unit, mounted as a portable instrument. (Center) Radiamatic sighted into furnace. (Lower) The Brown Circular Chart ElectoniK Recording Potentiometer.

# How Hot is a Flame?

**Human eyes can only guess—"Luminosity" is not the complete answer — recorded measurement of radiation characteristics is!**

**Chart records of flame radiating characteristics make possible greater heat input from fuel, higher tonnage, and lower fuel consumption per ton of steel produced.**

**Faulty conditions and inefficient furnace operation are often quickly revealed, and supposedly "ideal" flames can be greatly improved with the aid of Brown ElectroniK Potentiometers and Radiamatic sighting units.**

**Accuracy of the Radiamatic is unaffected by vibrations, dust, fumes and corrosive atmospheres. It is compensated for ambient temperatures and does not require water cooling.**

**Flame measurement is recorded by the Brown ElectroniK Potentiometer, which operates on the "Continuous Balance" principle, and provides instant response and unusual ruggedness.**

**As illustrated at left, the ElectroniK may be mounted easily on a cart, and moved readily for use at several furnaces.**

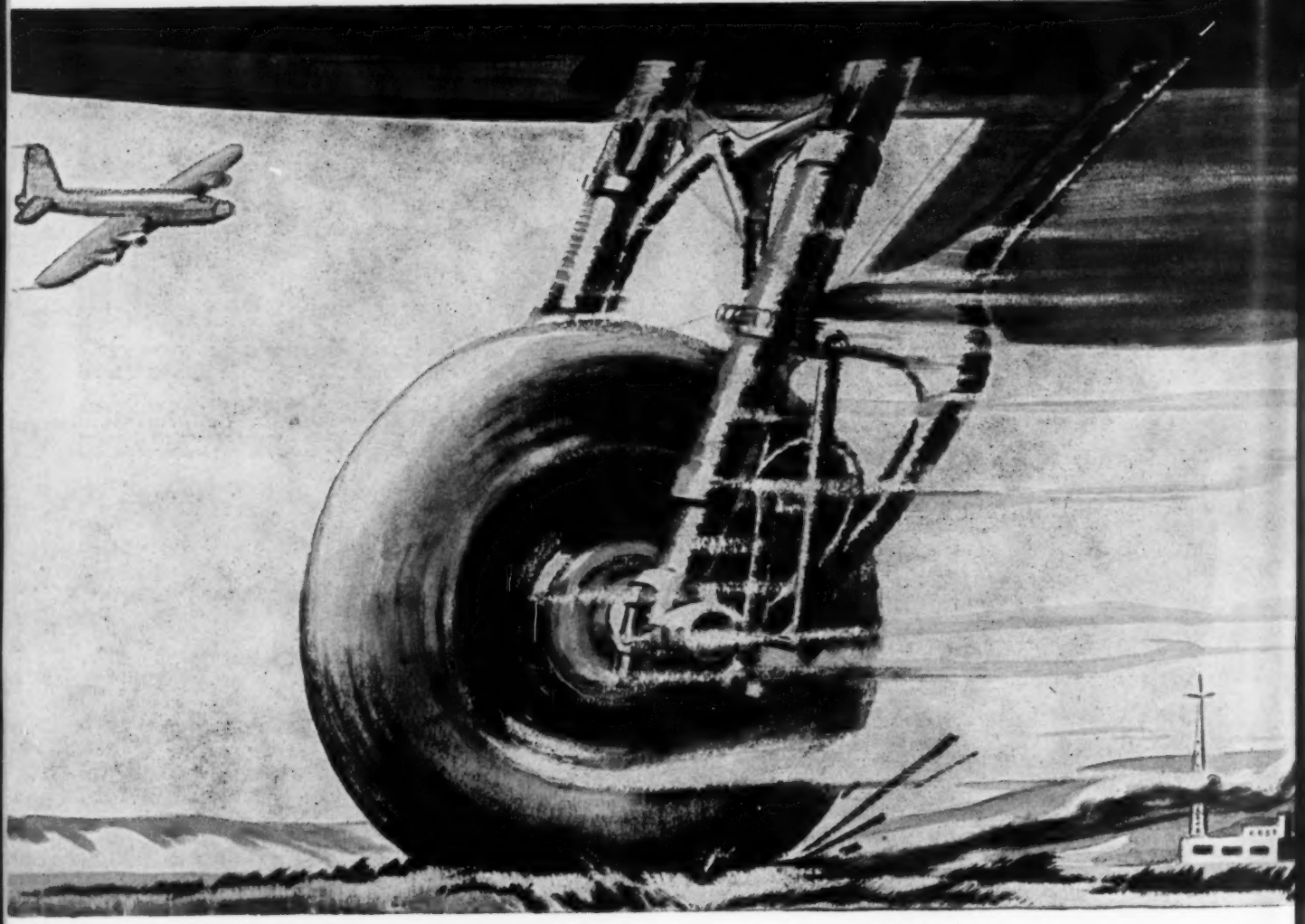
**Flame measurement is only one of many applications where the Brown ElectroniK and Radiamatic system is solving temperature problems in the operation of open hearths, soaking pits, blast furnaces, reheating furnaces and checker chambers of leading steel mills.**

**See what these instruments can do for you. Write for bulletin No. OH-1, "Measurement of Flame Radiating Characteristics"; ElectroniK Catalog No. 15-5; Radiamatic Catalog No. 5102. THE BROWN INSTRUMENT COMPANY, a division of the Minneapolis-Honeywell Regulator Co., 4464 Wayne Avenue, Philadelphia 44, Pa. Offices in all principal cities. 119 Peter Street, Toronto, Canada; Wadsworth Road, Perivale, Middlesex, England; Nybrokajen 7, Stockholm, Sweden.**

BROWN *Electronik* POTENTIOMETERS

# "UNIVAN"

That Tough Steel



## 65,000 lbs. hitting at 100 miles per hr.

## ....they've got to stand the Shock!

With higher mathematics you may be able to compute that impact.
But any way you figure it, tires, undercarriage and plane
must absorb a terrific shock at every landing.

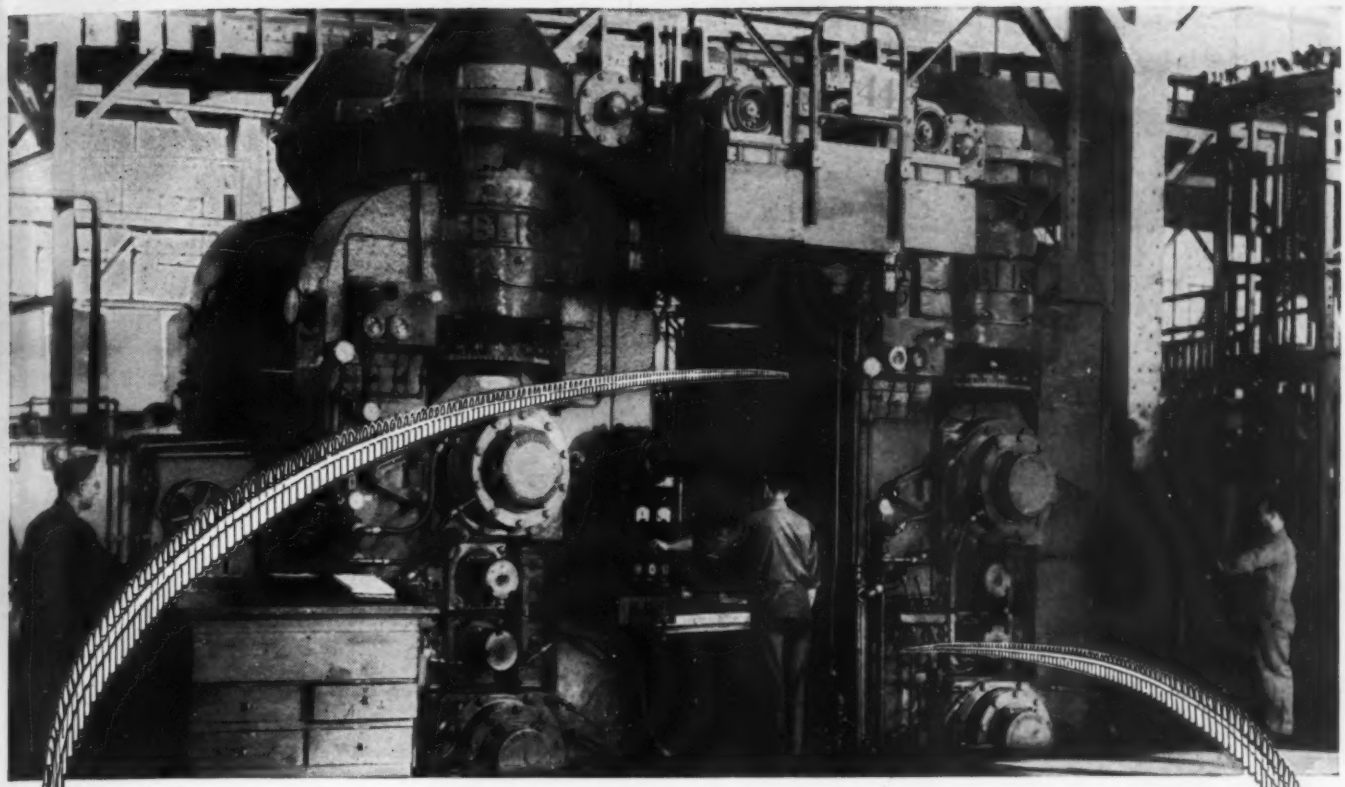
Your alloy steel casting requirements may not call for such severe service,
but if they *do*, it's safe to specify "Univan"—*that tough steel*
which withstands unusual stresses and shock with notable lack of fatigue.

Take advantage, too, of Union's long experience
in whipping the "trouble jobs" of industry.

# UNION STEEL CASTINGS

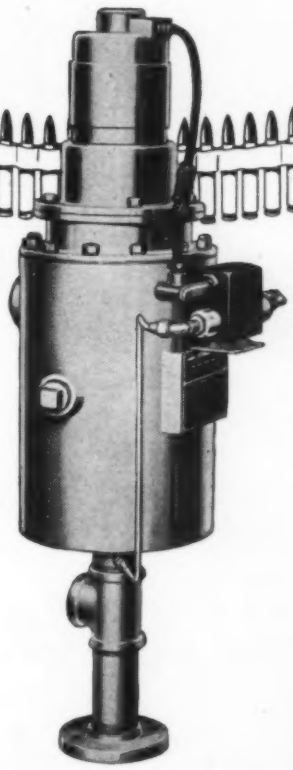
DIVISION OF
BLAW-KNOX CO.
PITTSBURGH, PA.

**MAKERS OF** Driving Wheel Centers, Locomotive Frames, Pump Casings, Vault Doors and Frames, Annealing Boxes, Spindles, Coupling Boxes, Open Hearth Charging Boxes, Gear Blanks — and other Castings for Steel Mills and General Industry



HOW BOWSER HELPS **WESTERN BRASS MILLS** PRODUCE

# Bullets by the Billion



More than a billion pounds of brass—every pound of which has been used in the production of an endless stream of cartridges for the United Nations—is the remarkable contribution to the war effort made by Western Brass Mills, division of Olin Industries, Inc.

This staggering figure represents a tonnage equivalent to a fleet of eleven modern battleships or aircraft carriers of 45,000 tons each!

A Bowser Lubrication-Filtration system has helped to keep this giant 4-high tandem brass mill running at full speed. Oil that is continuously filtered is pressure-circulated to every moving part, thus preventing bearing failure which would mean a costly shut down and the loss of millions of urgently needed cartridges.

The steel industry, too, knows the outstanding performance of Bowser equipment. Bowser lubrication for mill stands, reduction gears, pinion gear sets, turbines, etc., has been adopted for 90 per cent or more of all steel production in the United States. Bowser coolant systems and Bowser meters for fuel oil are also widely used.

Bowser installations are engineered to be integral parts of the mill. That's why Bowser leads the field. For complete information, write BOWSER, INC., Dept. 13-H, Fort Wayne 2, Indiana.

Not only has Bowser's war production earned the Army-Navy E . . . Bowser equipment has helped earn it for scores of other companies.

**BOWSER**

SINCE 1885

THE NAME THAT MEANS EXACT CONTROL OF LIQUIDS

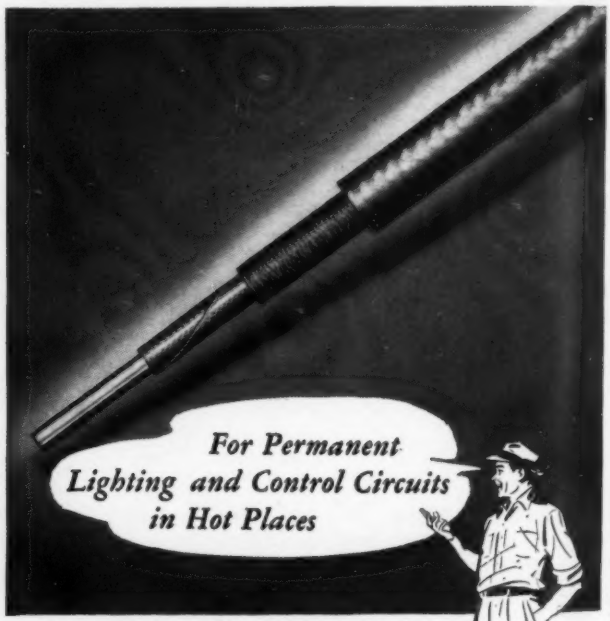
# Time to rewire the Hot Spots

Now that you can *select* whatever you want in wire and cable it's time to take a trouble-shooting trip around your plant . . . check up on war-weakened power, lighting and control circuits that run around boilers, furnaces, steam lines, soaking pits, kilns, lehrs or other hot spots . . . and don't forget the motor leads that have taken more than their share of over-load-heat, oil or grease. Then plan to replace all emergency war-time wiring that won't take years of abuse in locations where *trouble* starts—with *permanently insulated* Rockbestos A.V.C.

Every wire, cable and cord in the Rockbestos line was designed to stand up in an installation where other wires failed. They are all highly resistant to heat, moisture, oil, grease, corrosive fumes and flame. And they eliminate wire-failures and prevent service interruptions.

**ROCKBESTOS A.V.C. 600 V. MOTOR LEAD CABLE**
**(Nat. Elec. Code, Type AVA—max. operating temp. 110°C.)**
Flexible conductor insulated with two impregnated felted asbestos walls and a high dielectric varnished cambric insert and covered with an asbestos braid. Resistant to heat, flame, moisture, oil and grease. Sizes No. 18 AWG to 1,000,000 CM.

**ROCKBESTOS A.V.C. 600 VOLT POWER CABLE**
**(National Electrical Code, Type AVA—max. operating temp. 110°C.)**
Insulated with two impregnated felted asbestos walls and a high dielectric varnished cambric insert and covered with a rugged asbestos braid—withstands heat and condensation in steam tunnels, boiler rooms, etc. In sizes No. 18 AWG to 2,000,000 CM.




**ROCKBESTOS A.V.C. 600 V. BOILER ROOM WIRE**
**(Nat. Elec. Code Type AVA—max. operating temp. 110°C.)**
Insulated with high dielectric varnished cambric, impregnated felted asbestos and covered with an asbestos braid. Heat, flame and moisture resistant for permanent control and lighting circuits in hot locations. In sizes No. 18 to 4/0 AWG.

*Send* for samples of these *permanently insulated* Rockbestos wires and a catalog describing many of our 125 standard constructions and Rockbestos-designed National Electrical Code types. Write to your nearest district office or:

**ROCKBESTOS PRODUCTS CORPORATION**
**601 Nicoll St., New Haven 4, Conn.**

# ROCKBESTOS A.V.C.

***THE WIRE***
***WITH PERMANENT INSULATION***

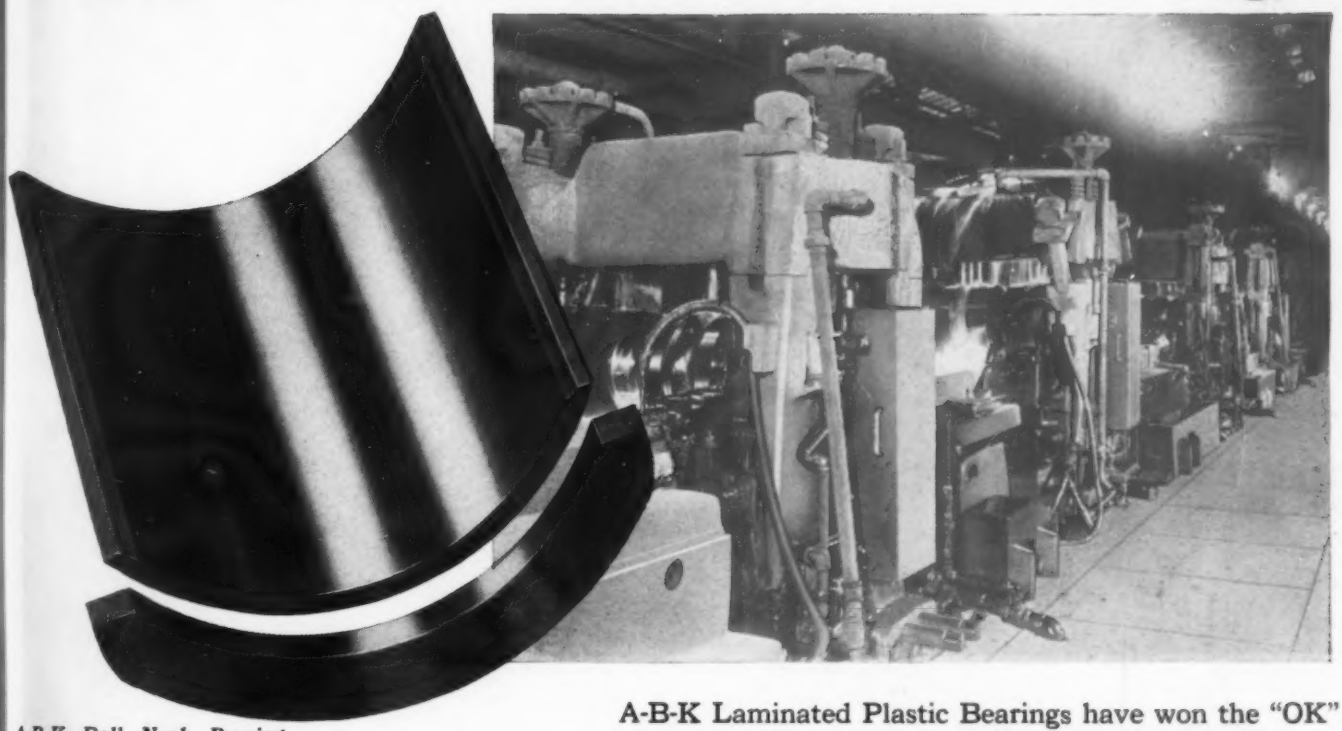
***FOR VICTORY . . . BUY MORE WAR BONDS***

NEW YORK BUFFALO CLEVELAND CHICAGO PITTSBURGH ST. LOUIS LOS ANGELES SAN FRANCISCO SEATTLE PORTLAND, ORE.

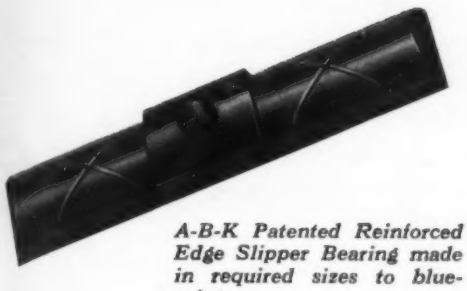
## Tonnage Goes Up—Power Costs Go Down

# A-B-K

# Laminated Plastic Bearings



*A-B-K Roll Neck Bearing with separate collar.*



*A-B-K Patented Reinforced Edge Slipper Bearing made in required sizes to blueprints.*

*Phantom view of A-B-K Patented Reinforced Edge Slipper Bearing.*

A-B-K Laminated Plastic Bearings have won the "OK" of many mill operators in today's record production.

More tons of steel per set of A-B-K Roll Neck Bearings—often 20 times as much as with metal bearings.

Savings up to 40% in power consumption are common in blooming, merchant and other steel mills using A-B-K Laminated Plastic Bearings.

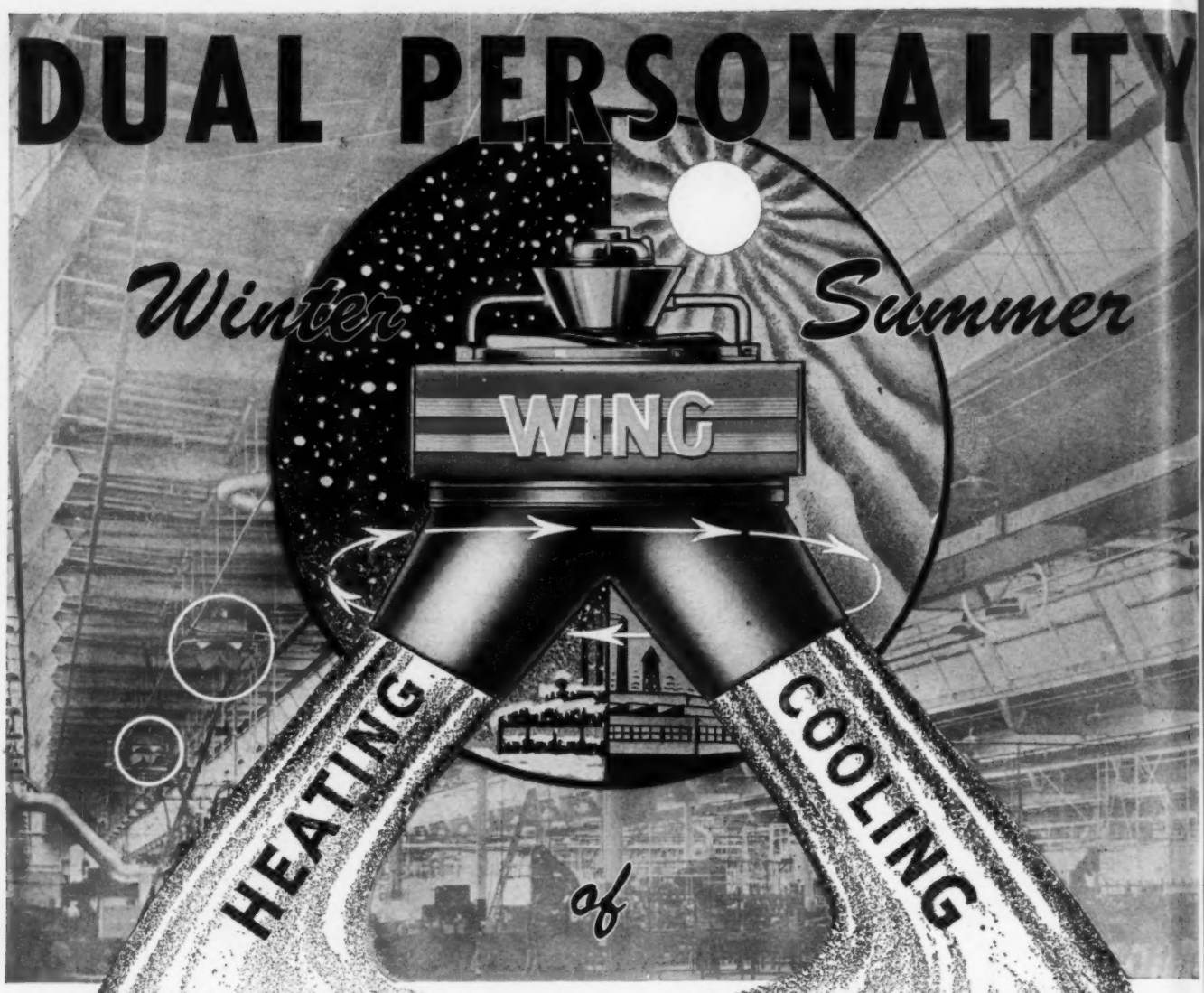
A-B-K Roll Neck and Slipper Bearings were developed by A-B-K engineers to meet the specific problems of steel mill operators.

For information on your problem, phone, wire or write American Brakeblok Division, Detroit 9, Michigan.

American Brakeblok

DIVISION OF AMERICAN Brake Shoe COMPANY

# DUAL PERSONALITY




## WING *Revolving* UNIT HEATERS

Many who have been aware of the superiority of Wing Revolving Unit Heaters for wintertime heating are just discovering for themselves the added value of these "heaters" in summer, when, with the steam turned off and the fans on, the revolving discharge outlets circulate the air with a pleasant cooling effect that reaches all workers uniformly.

As the moving streams of air sweep slowly around through 360 degrees, they cover successively every direction, mixing the air uniformly and creating a delightful cooling effect that is equally effective in stimulating production in hot weather as is accomplished with the heated air in winter.

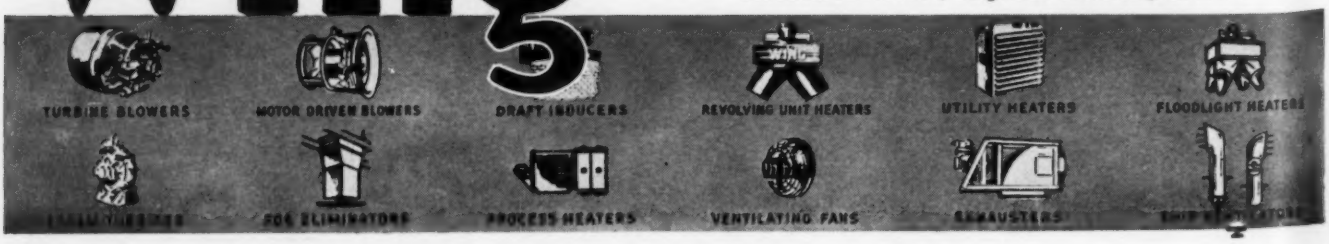
*Write for a copy of Bulletin HR-4.*

**Wing**

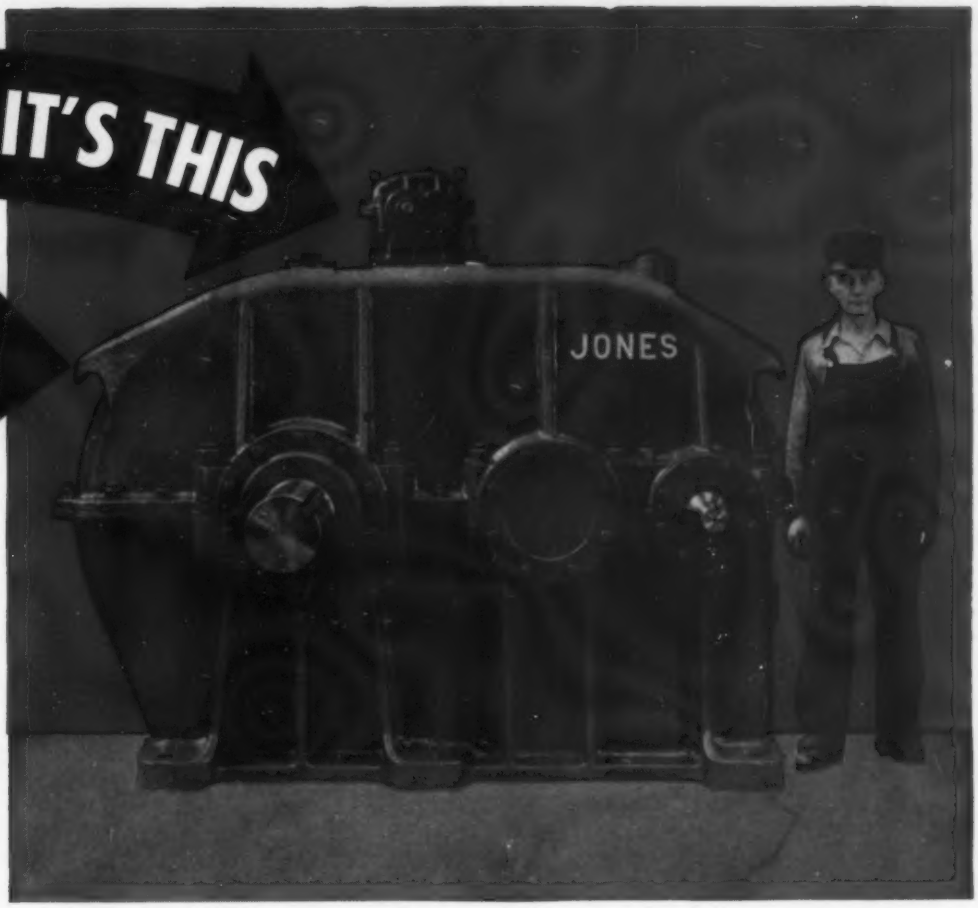
**L. J. Wing Mfg. Co.**

**14th St. and 7th Ave., New York 11, N. Y.**

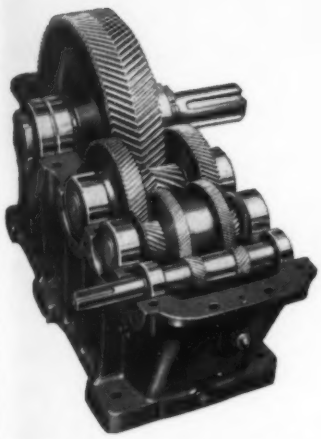
*Factories in Newark, N. J. and Montreal, Canada*



# WHETHER IT'S THIS —OR THIS




## . . . both will stand up under war time conditions



The above view of a Jones Triple Reduction Herringbone Speed Reducer is typical of a line that is noted for advanced design, superior materials, precision workmanship.

TWENTY FOUR hours a day operation plus loading up to rated capacity or beyond are testing speed reducers in every type of service.

Jones Herringbone Speed Reducers are establishing remarkable service records under these conditions. One reason of course is the fact that Jones Reducers have always been rated in accordance with the recommended practice of the American Gear Manufacturers Association.

With this conservative rating policy goes sturdiness, compactness, symmetry and balance—all factors that influence maximum efficiency, long life and improved performance.

Jones Herringbone Gear Speed Reducers are built in a wide range of ratios and ratings to cover every requirement. Single (Type SH) reducers in standard ratios range from 1.25 to 1 up to 11 to 1 in ratings from 1.3 to 440 H.P. Double (Type DH) reducers are built in standard ratios from 10.9 to 1 up to 72 to 1 in ratings from 0.5 to 275 H.P. The triple reduction reducers (Type TH) cover a range of ratios from 86.9 to 1 up to 355.8 to 1 in ratings from 0.3 to 78 H.P.

All these reducers have heat treated gears, ground shafts and are mounted with anti-friction bearings throughout. Cast iron bases are available for all variations of motor assembly.

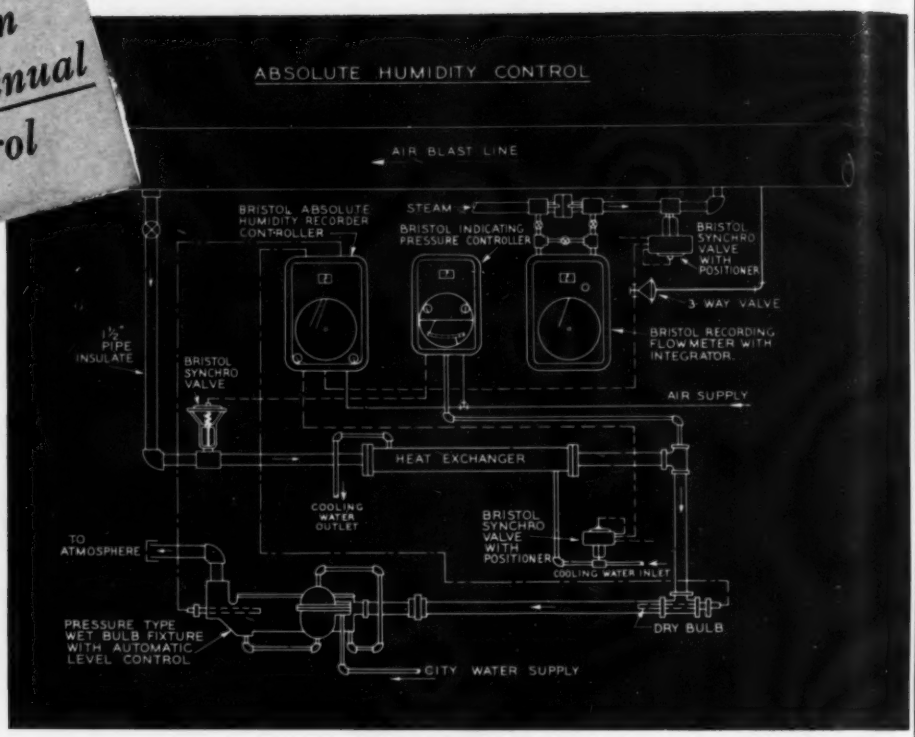
For complete information on both standard and special applications of Jones Herringbone Reducers ask for Catalog No. 70. This 128 page catalog is a comprehensive technical treatise on the whole subject of Herringbone Reducer application for all conditions of service. If you have any type of drive problem that might call for Herringbone gears we shall be pleased to send you a copy.

**W. A. JONES FOUNDRY & MACHINE CO.,** 4431 **Roosevelt Road, Chicago, Ill.**

# Jones

# WET BLAST... OR WETTER

*best furnace operation depends upon continual humidity control*




Whether you favor a relatively low or high humidity level in blast furnace air, you'll agree that better results are obtained when the moisture is maintained at a *uniform* level.

Bristol's Humidity Control System provides a continuous and absolutely accurate record of humidity and, where moisture injection into the blast main is desired, operates an automatic steam control valve. If the natural moisture is below the set point, the controller adds moisture to maintain a higher pre-determined constant moisture level. Or, if moisture is not to be added, the controller can perform other functions.

No attendant is required. There is no chance of personal error in reading or interpreting wet and dry bulb measurements. There is no danger of moisture-content being upset by a considerable change in natural moisture which sometimes occurs between periodic readings under manual control.

**Low Cost Quickly Returned**

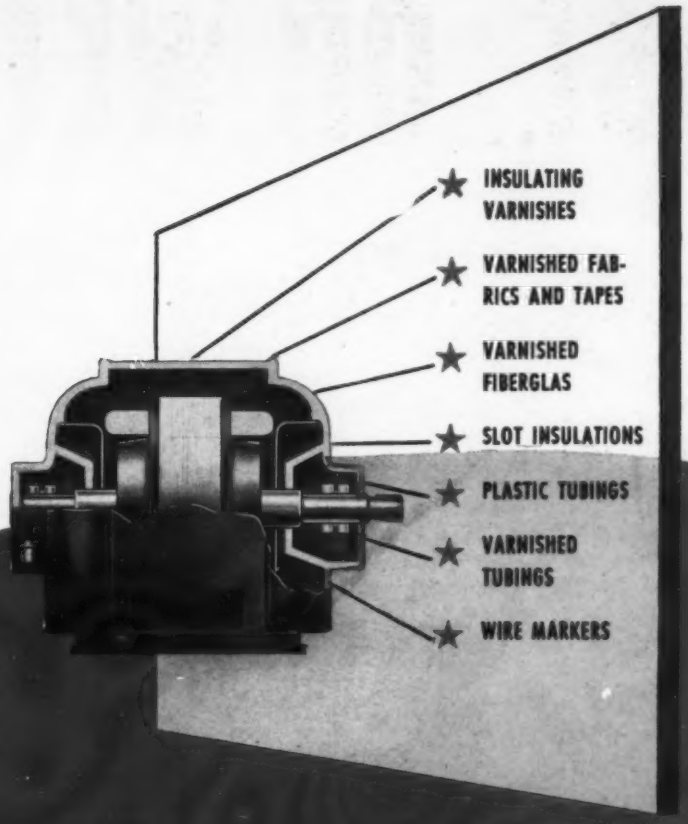
A Bristol absolute humidity control system can be installed at less than 2% the cost of a dry blast system for a 1000-ton furnace. The equipment soon pays for itself by:

1. Improving furnace regularity and the ability of the furnace to "take the wind" with fewer checks and furnace hangings or slips.
2. Giving better control of iron quality through better silicon control. Fewer excess silicon heats save processing time and limestone at the open hearth. If furnace product is Bessemer blowing iron, moisture control has proven to be especially advantageous.

For further facts, ask us to send you Bulletin 127. Address THE BRISTOL COMPANY, 123 Bristol Rd., Waterbury 91, Conn. (The Bristol Co. of Canada, Ltd., Toronto, Ontario. Bristol's Instrument Co., Limited, London, N.W. 10, England).

**BRISTOL** ... *Gives YOU the Most from Heat*

AUTOMATIC RECORDING AND CONTROLLING INSTRUMENTS



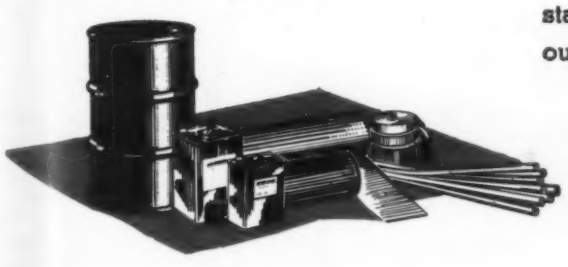

# *Completely* INSULATED

## *by the Leader in Insulation!*

Motor manufacturers have come to the realization that the specification "Completely Insulated by Irvington" means longer motor life with less chances of electrical failures. Basic to this is the fact that every Irvington insulation has been formulated to produce definite and outstanding characteristics — resistances to the agents of motor destruction — heat, corrosive fumes, excessive moisture etc. Insulations have been designed for regular and unusual motor needs — matched to work with each other for blended, smooth acting motor performance — to produce long-lasting and dependable motors. From this one source, *Irvington*, you can obtain insulations not only for motors but for all other electrical equipment as well. Each and every product is kept to Irvington's high standards by strict laboratory and production control. We offer our cooperation and invite your inquiries. Write Department 60

**IRVINGTON PRODUCTS include:**

***Core Plate, Finishing and Sticking Varnishes • Varnished Canvas and Duck • Varnished Nylon, Rayon and Silk • Varnished Papers • Insulating Punchings • Fibron Plastic Tapes • Cardolite Compounds***



**IRVINGTON**
**VARNISH & INSULATOR COMPANY**
**Irvington 11, New Jersey, U. S. A.**

Section view: Note long distances from contact to contact and from contacts to ground.

# QUELARC

## The circuit breaking plugs and receptacles . . . ratings up to 200 amperes

Pyle-National plugs and receptacles are built to stand up in mill service, delivering dependable service with minimum maintenance. The exclusive QuelArc construction provides exceptional protection to contacts, for safe use as current rupturing devices. In the section view, note the complete enclosure of all contacts in insulating chambers which form an arc-trapping space. Note also the long distances from contact to contact and from contacts to ground. Contacts are individually renewable. Full ground protection is provided.

QuelArc plugs and receptacles are available in a complete range of styles, 2, 3, 4 wire types; ratings 20, 30, 60, 100, and 200 amperes. Many other types available for portable tools and control and instrument circuits. Write for general catalog 1100 with listings of all types.

**THE PYLE-NATIONAL COMPANY**
**1334-58 North Kostner Avenue • Chicago 51, Illinois**
**Offices: New York, Baltimore, Pittsburgh, St. Louis, St. Paul, San Francisco**

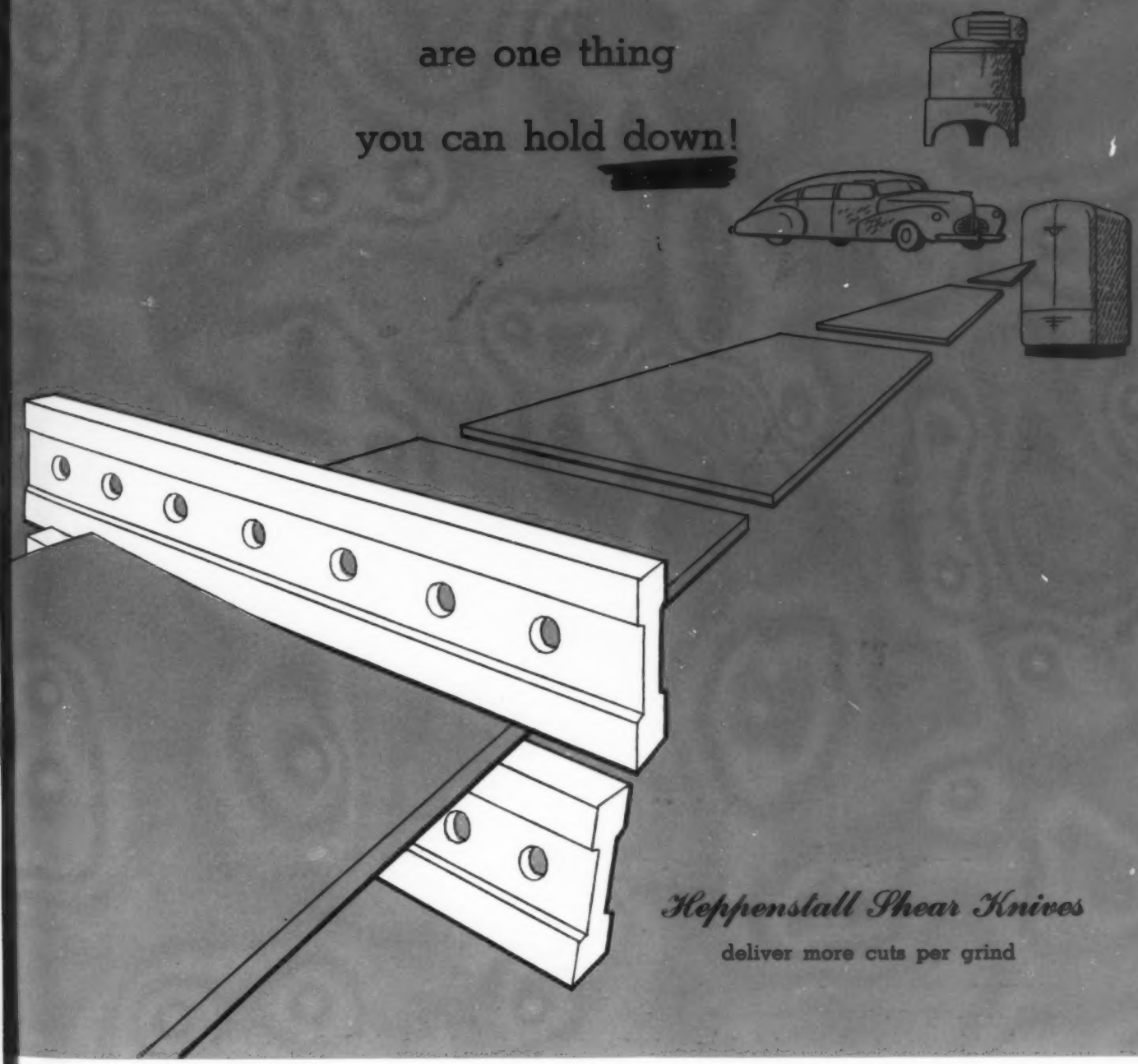
PYLE-NATIONAL
ELECTRICAL EQUIPMENT
• SINCE 1897 •

**CONDUIT FITTINGS • FLOODLIGHT PROJECTORS • LOCOMOTIVE ELECTRICAL EQUIPMENT**

# Shearing costs

are one thing

you can hold down!



*Heppenstall Shear Knives*

**deliver more cuts per grind**

Not just because we're the oldest and largest maker of solid tool steel knives—not because our knives have set such remarkable performance records in other plants—BUT because we *know* that our knives, in your mill, under your own operating conditions will give you more and cleaner cuts per dollar of cost . . . we recommend Heppenstall knives as a basic and proved advantage in meeting tougher marketing competition. Write for a quotation. Heppenstall Co., Pittsburgh 1, Pa.

## Heppenstall

the most dependable name in forgings

# POOLE

A COPY OF CATALOG GIVING FULL DESCRIPTION AND ENGINEERING DATA SENT UPON REQUEST.

# FLEXIBLE COUPLINGS

POOLE FOUNDRY & MACHINE COMPANY

WOODBERRY, BALTIMORE, MD.

# *"Our* BAKER TRUCK *got us out of a* TOUGH SPOT! *"*

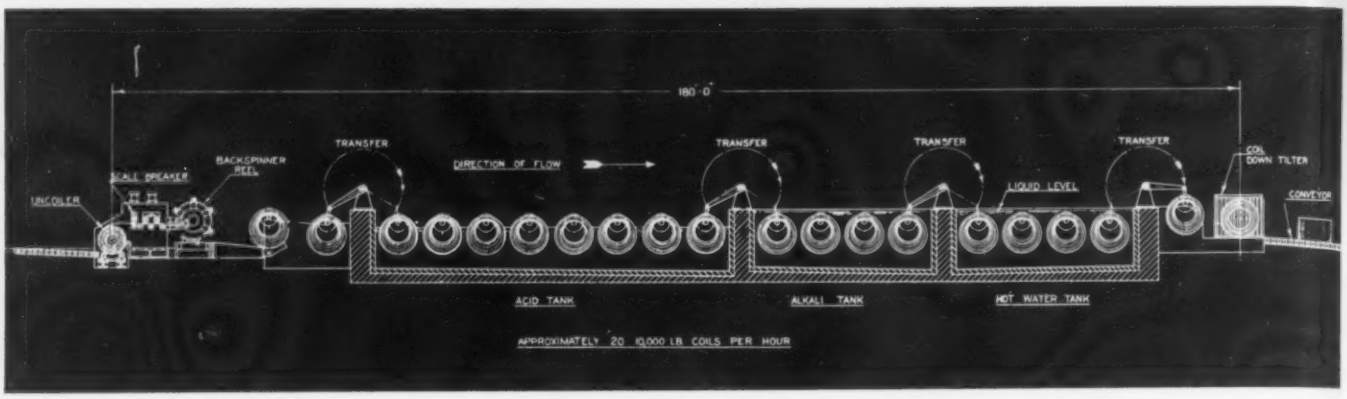
## Unloaded 28 Fifty-Ton Carloads of Steel—Moved 1000 Tons from receiving platform to storage in First 3 Weeks

Before this large steel distributor purchased his Baker Truck, he faced an acute manpower shortage. Carloads of steel were crowded on his sidings, his receiving platform was jammed. *In the first three weeks of service, his Baker Crane Truck helped unload 28 fifty-ton carloads and moved 1000 tons from receiving platform to storage.* By doing work that formerly required 12 to 15 men, the truck is now keeping steel moving in this huge warehouse—about half of which is beyond the limits of overhead cranes. Illustration shows the truck loading about 4000 lbs. of bar stock onto a trailer, to be drawn by tractor to the loading platform. Truck also loads steel directly onto highway trucks, conserves manpower and saves time on many other handling operations.

*The new Baker Catalog No. 52 describes many case histories showing how Baker Trucks have solved similar problems in a wide variety of installations. Call your nearest Baker representative or write for your copy today.*

**BAKER INDUSTRIAL TRUCK DIVISION of the Baker-Raulang Co.**
**2166 West 25th Street • Cleveland, Ohio**
*In Canada: Railway and Power Engineering Corporation, Ltd.*

# CONTINUOUS STRIP PICKLING IN COILS




The coils follow each other through the acid, alkali and wash tanks at approximately 20 coils per hour. The frequent aeration of the coils produces a product of superior quality.

MINIMUM FLOOR SPACE • LOW OPERATING COST

LARGE TONNAGE • SUPERIOR PRODUCT

**Sole Licensee**
**Under Greer Patents**

## THE ARMS-FRANKLIN CORPORATION

Engineers and Builders of Rolling Mill Machinery

**YOUNGSTOWN 3, OHIO**

NEWS SUPPLEMENT August, 1945

Equipment
Personnel
Literature

Iron AND Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

## PRODUCTION OF EXPANDED SLAG AGGREGATE STARTED AT SOUTH CHICAGO PLANT

▲ The manufacture of lightweight Celocrete aggregate has just begun in a newly opened government-owned plant at South Chicago, Illinois. The plant is operated by the Republic Steel Corporation and is ideally situated to take care of an increasing demand for lightweight aggregate for concrete construction in the midwest states.

The expanded slag of which Celocrete aggregate is composed is manufactured in this new plant by the most modern methods and equipment. Crusher, screens and expanding machine are all of the very latest type. The plant itself is the largest of its kind in the United States.

When The Celotex Corporation first began the merchandising of lightweight aggregate seven years ago, the program called for plants strategically located throughout the country, but this program has had to be somewhat modified due to war conditions. The South Chicago plant brings the total number of Celocrete manufacturing units to five. Other plants are located at Cleveland, Buffalo, Pittsburgh and Troy, New York, and the building of still others is contemplated as conditions permit.

Shipment from the South Chicago unit can be made by rail or highway. Storage facilities are available for about 30 carloads of finished material in covered bins.

Concrete products manufacturers are experiencing an increasing preference for lightweight materials manufactured from expanded slag products for many types of construction. Durability, insulation against both heat and sound, lightness in weight and color, and workability, are some of the properties of these materials which have come to be recognized by consumers in growing numbers.

**Overall view of the recently opened expanded slag plant for the manufacture of lightweight Celocrete aggregate, at Republic Steel Corporation's works, South Chicago, Illinois. Here are shown the crusher house, conveyor system, delivery bin and clinker dock.**

## COLD WEATHER LUBRICANT FOR COMBUSTION ENGINES

▲ A new internal combustion engine lubricant having unusual advantages over mineral oil, particularly for cold weather use, has been announced by Carbide and Carbon Chemicals Corporation, a unit of Union Carbide and Carbon Corporation. This lubricant, which is now being produced in commercial quantities, has properties quite different in many respects from oils derived from petroleum.

The lubricant can be manufactured to any desired viscosity and is wax-free. Pour-points vary from 30 to 80 F. Flash points range from 300 F up. The new materials have densities approximating that of water. Carbon residue values are less than 0.01 per cent, regardless of viscosity. The lubricant is characterized by low change of viscosity with change in temperature, having viscosity indices in the range of 140 to 160.

Carbide's new lubricant contains no petroleum oils. Its use in internal combustion engines has been studied for several years in a large number of vehicles which have covered a total of over one and one-half million road miles. Large quantities are being used in military equipment.

PHILCO
gives you the latest in
Modern Battery
Design !
THOUSANDS of electric industrial trucks are now getting more work done at lower cost because of the advanced research of Philco engineers in developing tougher, more powerful storage batteries. Philco has long led in providing batteries of maximum capacity, with the rugged long-life construction especially engineered for today's heavier work schedules.
Now Philco engineering leadership is demonstrated anew with the storage battery that gives 30% longer life — the great new Philco "Thirty"! For lower cost in handling materials with electric trucks, be sure to include the new Philco "Thirty" in your plans. Now available in preferred types. Complete information gladly sent on request. PHILCO CORPORATION, *Storage Battery Division*, Trenton 7, New Jersey.
For 50 years a leader in Industrial Storage Battery Development
The new Philco "Thirty" with 30% longer life is identified by its distinctive red connectors.

These new lubricants practically eliminate sludge and varnish formation in the engine. Wear of the moving parts is in line with wear experienced with ordinary mineral oils. Ease of starting in cold weather is an outstanding advantage.

There are indications already that these lubricants will be widely used in internal combustion engines when they are available for other than critical military use. These compounds are manufactured in two types, water soluble and water insoluble. The latter type is used for lubricating internal combustion engines. Other applications include lubrication of refrigerating machines and all kinds of machinery operated under conditions of low temperature or where a non-sludging oil is required, and as hydraulic fluids, textile lubricants, plasticizers, in leather treating compounds, wire drawing lubricants and heat transfer liquids. Greases having unusual high- and low-temperature properties have been prepared from these lubricants.

## LABORATORY FURNACE HAS WIDE RANGE OF USES

▲ Designed to fulfill the requirements of a wide variety of applications, a new "three-way" bench type universal laboratory furnace is now available from Surface Combustion Corporation, Toledo, Ohio. Controlled operation over a wide range of temperatures further enlarges its field of use.

The furnace combines three different types of furnaces in one casing. It may be used as a direct-fired oven unit at temperatures from 300 F to 2400 F. For direct heating a muffle can be placed on the hearth. If an atmosphere is desired a diamond block can be used in the muffle. A removable plug built into the arch of the furnace provides a means of inserting a pot.

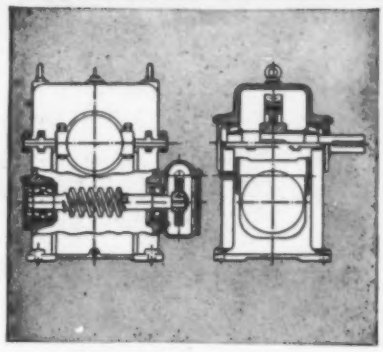
This laboratory furnace is ideal for small shops or laboratories where a wide variety of heat treatments in relatively small quantities of small parts must be performed. Such operations as annealing, carburizing, hardening, cyaniding and tempering, with or without a furnace atmosphere can be handled by the one furnace. It functions as a direct-fired oven, indirect heated muffle, gaseous atmosphere, salt or lead bath type and may also be used for melting soft and light metals such as tin, lead, aluminum, magnesium, etc.

The furnace is equipped with three atmosphere-type gas burners, each of which can be independently controlled. The burners are arranged under the hearth to provide uniform and rapid heating throughout the heating chamber. A gas pressure regulator assures uniform control of burner operation. Fuel under low pressure without air under pressure is sufficient for burner operation, such as manufactured or natural gas at 3 to 6 inch water pressure, or butane or propane at 9 to 11 inches pressure.

Dimensions are as follows: Hearth width and length, 6 by 12 inches. Door width and height, 5¼ by 4¼ inches. Overall dimensions, width 19½ inches, length 21⅝ inches, height 29 inches. Hours to heat from cold to 2400 F — 2. Maximum gas demand 90,000 Btu per hour. The unit is designed as universal laboratory furnace UL-6-12 and detailed specifications are now available.

**Surface Combustion universal laboratory furnace with accessory equipment including (A) muffle, (B) protective atmosphere equipment, (C) plug, and (D) pot.**


LUBRIPLATE No. 8



FOR HEAVY GOING

LUBRIPLATE No. 8 possesses an extremely high film strength and is just the correct density for the general run of enclosed gears (speed reducers). It is especially suitable for worm gears and other types carrying heavy loads. Typical of all LUBRIPLATE lubricants, No. 8 has exceptionally long life.

℞ FOR YOUR MACHINERY

No. 3—Ideal for general all type lubrication. Ring oiled bearings, wick feeds, sight feeds and bottle oilers.

No. 8—Because of its high film strength and long life reflects outstanding performance in most types of enclosed gears (speed reducers).

No. 107—One of the most popular grease type products for general application by pressure gun or cups.

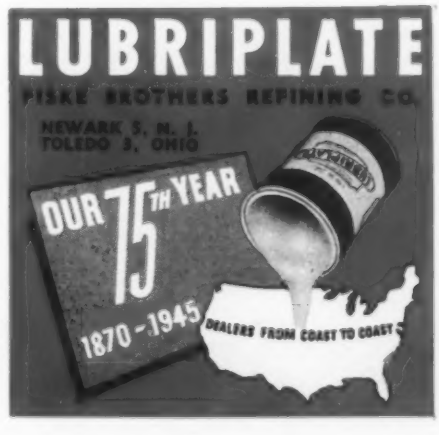
No. 70—For a wide range of grease applications, especially at temperatures above 200 degrees F.

No. 130-AA—Known nationwide as the superior lubricant for open gears, heavy duty bearings, wire ropes, etc.

BALL BEARING—This is the LUBRIPLATE lubricant that has achieved wide acclaim for use in the general run of ball and roller bearings operating at speeds to 5000 RPM and temperatures up to 300 degrees F.

Write for a booklet, "The LUBRIPLATE Film", written especially for your industry.

LUBRIPLATE
FISKE BROTHERS REFINING CO.
NEWARK 5, N. J.
TOLEDO 3, OHIO



## NEW A-C WELDER IS BUILT IN TWO CURRENT RANGES

▲ A new 200 ampere Wilson "Bumblebee" transformer welder to meet the need for a high quality a-c machine of medium capacity, incorporating the latest features for economy in power consumption and high-speed, quality welding, has been announced by Air Reduction.

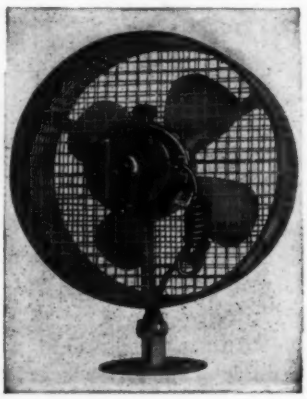
Built-in capacitators make possible power economies up to 35 per cent, reduce power bills and power input, and relieve overloaded transmission and plant feeder lines, making room for additional equipment. The unit is also equipped with a disconnect switch.

Self-contained, the new 200 "Bumblebee" has two ranges of current, the low from 30 to 110 amperes and the high from 90 to 275 amperes. Continuous stepless current control is provided throughout each current range by simply turning the crank on the top of the machine. A full-view scale makes current settings easy to read at all times.

The machine is entirely self-contained and is sturdily constructed for dependable, economical service. All windings are covered with the latest spun-glass fibre, heat-resistant class B non-inflammable insulation.

Illustrated leaflets giving dimensions, operating data, electrical characteristics, graphs of volts and efficiency and power factors percentages and other data are available on request from Air Reduction Sales Company, 60 East 42nd Street, New York 17, New York.


IS HEAT SLOWING UP YOUR WORKMEN?



TRUFLO CRANE CAB FANS
For cooling interiors of crane cabs and other confined areas. Adjustable both horizontally and vertically. Four blade type, 12 and 18 in. sizes.

Keep Them COOL with TRUFLO FANS

TRUFLO PORTABLE COOLING FANS
Easily portable. Help keep efficiency high where work is hottest. 12 to 36 inch diameters.

Production suffers when workmen are overheated. Steps begin to drag, efficiency falls.

Now, when speedy production is vital, Truflo Fans can help keep your workmen on their toes. All Truflo Fans are designed and built correctly to put fresh cool air *in large volumes* exactly where it is needed. Perfectly-balanced shafts and blades give more air per h.p. . . . strong steel frames stand up longer under hard use . . . rugged wire guards protect men against injuries.

All of the following types can help beat the heat, keep production moving in your plant. Write for illustrated literature.

PORTABLE COOLING FANS
CRANE CAB FANS • WALL FANS
EXHAUST FANS • BLOWERS
ROOF VENTILATING FANS
PENT HOUSE FANS

TRUFLO FAN COMPANY
554 MAIN ST., HARMONY, PA.


## EMERGENCY ALARM ADDED TO CONTROL INSTRUMENT

▲ A new safety emergency alarm feature that protects process equipment and materials has been added by the Brown Instrument Company to its line of electronic air-operated controllers.

The new feature, known as the Brown ElectroniK contact controller, provides safety alarm principles that operate automatically. It also provides on-off control in addition to air control to actuate motorized valves, solenoid valves, contactor panels, signal lights, etc.

As shown in the accompanying picture of the contact controller, contacts (A) and (B) are made or broken by the action of cam (C) and roller (D), and the spring loaded lever to which it is attached. The control point is set by loosening the knurled knob (E) and rotating cam (C), so that its notch corresponds to the position of the temperature pen that has been previously moved to the desired point. The pen position sounds the emergency alarm. A red pointer on the scale indicates the temperature setting of the contact controller.

The new equipment can be used in

steel, petroleum, chemical, plastic and over 60 other major and related processing industries.

## CONTROL MANUFACTURE BY NEW CORPORATION

▲ Piezo Manufacturing Corporation has become the exclusive manufacturer of all remote control equipment formerly manufactured by Piezoelectric Corporation. The successor company will continue to sell remote control joints, assemblies and related accessories throughout the United States and Canada.

Management and facilities remain at 110 East 42nd Street, New York 17, New York. Manufacturing facilities will continue operation at New Dorp, Staten Island, New York.

## ELECTRODE FOR A-C, D-C WELDING OF INCONEL

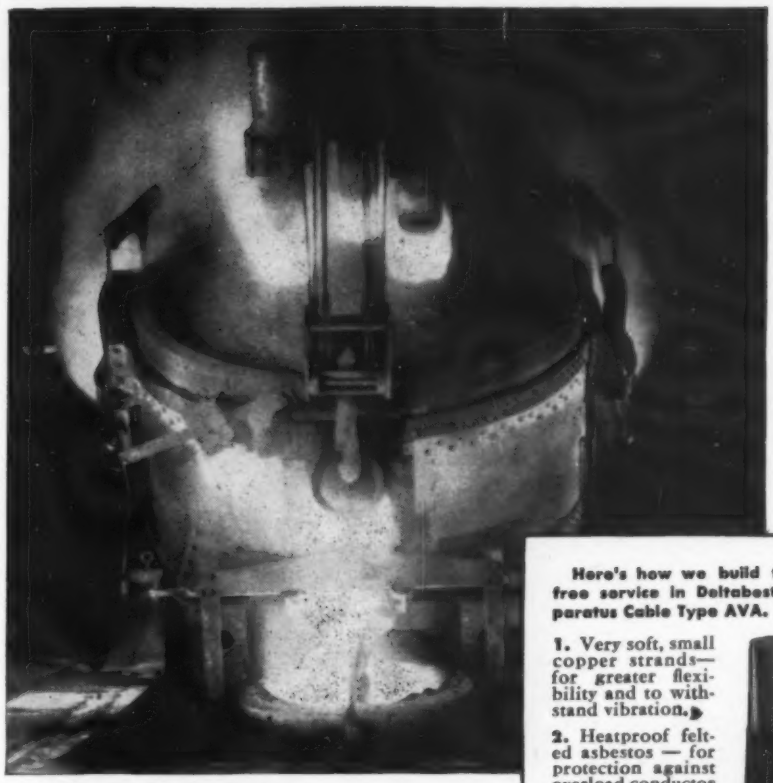
▲ Production of a new Inconel welding electrode, suitable for both a-c and d-c welding of wrought Inconel, cast Inconel and the Inconel side of Inconel-clad steel, has been announced by The International Nickel Company.

The new rod is now in production at the company's Bayonne Works and is regarded by engineers as a long step forward in the development of welding electrodes for use with both alternating and direct current. The new electrode is of particular importance for welding of Inconel in such fields as chemical and aviation industries, as well as in the general metallurgical fields.

Characterized by improved arcing qualities, simplicity of slag removal, and an ability to make crack-free welds in any thickness, this electrode may be used on either straight or reversed polarity with direct current motor generator sets.

Recommended amperages for the Inconel welding electrode, based upon electrode diameter, are indicated in the following table prepared by the development and research division of The International Nickel Company.

| Electrode diameter, in. | Recommended amperage a-c | d-c |
|---|---|---|
| .075 | 40-50 | 30-40 |
| 3/32 | 45-60 | 35-50 |
| 1/8 | 90-110 | 80-100 |
| 5/32 | 130-150 | 110-130 |
| 3/16 | 150-170 | 130-150 |

Here's how we build trouble-free service in Deltabeston Apparatus Cable Type AVA.

1. Very soft, small copper strands—for greater flexibility and to withstand vibration.
2. Heatproof felted asbestos — for protection against overload conductor heat.
3. Varnished cambric—for moisture resistance and high dielectric strength.
4. Felted asbestos —for extra protection against high ambient temperatures.
5. Asbestos braid —for high resistance to heat, moisture, oil, grease and most corrosive vapors.

# Deltabeston Cables Withstand High Heat

Electrical circuits that run around boiler rooms, steam tunnels, soaking pits, pouring ladles and other hot spots are bound to fail frequently unless cable insulations can withstand high operating temperatures. One of the safest ways to provide uninterrupted electrical service in these torrid zones is to protect with Deltabeston Asbestos-insulated Power and Motor Lead Cables. These heat-resistant cables have proved in countless installations that the asbestos-insulation just won't bake out despite constant, high heat.

If excessive heat is causing frequent power failures in your mill, investigate G-E Deltabeston Asbestos-insulated Cables now. Deltabeston is used extensively for power, lighting and control circuits especially where severe operating conditions prevail. General Electric manufactures a complete line of asbestos-insulated cables including many special designs. They're constructed not only to withstand excessive heat but high humidity, oil, grease and most corrosive vapors.

For additional information write to Section Y853-31 Appliance and Merchandise Dept., General Electric Company, Bridgeport, Conn. Deltabeston Wires and Cables are distributed nationally by Graybar Electric Co., General Electric Supply Corp., and other G-E Merchandise Distributors.

BUY WAR BONDS AND KEEP THEM

GENERAL ELECTRIC

• *One* Johns-Manville insulating Fireblok has more surface area than *five* ordinary fire brick. The saving in installation time is apparent . . . as is the reduction in costly furnace down-time.

The four types of Johns-Manville Insulating Fireblok (lightweight insulating refractory linings in block form) are suitable for the same service and temperature ranges as the four well-known J-M Insulating Fire Brick. The only difference is size . . . an installation of the much larger Fireblok can be completed in much less time than with standard size brick.

In addition to its larger size, J-M Fireblok also has these important advantages:

**Easy Cutting and Fitting**—can be cut with a saw and shaped with a rasp. Most special shapes can be cut from standard slabs, reducing the inventory of special shapes.

**Minimum of Joints**—the large size, compared to standard fire brick, materially reduces number and length of joints, resulting in thermally more efficient construction.

**Economical Bonding**—with reduced joint length, Fireblok requires a minimum of airset cement for bonding. (J-M 1626 Cement was especially developed for this use.)

**Uses**—use Fireblok wherever insulating Fire Brick is recommended, as for industrial furnaces, flues, stacks, etc. Fireblok is particularly suitable for the lining of doors, for suspended arches, and when tapered, for sprung arches of exceptional stability.

Fireblok is one of many scientific insulations developed through years of Johns-Manville research. This background of industrial insulation experience is available to help you with your planning. Call or write your nearest J-M office.

**Installing J-M Fireblok** on a suspended arch-type furnace, using convenient J-M hanger supports. Despite the large size of Fireblok, it is light in weight . . . easily handled.

**4 Types Available:**

JM-1620 Fireblok for exposed temp. to 1600°F. As back-up to 2000°F.
JM-20 Fireblok for use up to 2000°F. Exposed or back-up.
JM-23 Fireblok for use up to 2300°F. Exposed or back-up.
JM-26 Fireblok for use up to 2600°F. Exposed or back-up.

**Johns-Manville**
22 East 40th Street, New York 16, N. Y.

**INDUSTRIAL INSULATIONS**
for every temperature—for every service

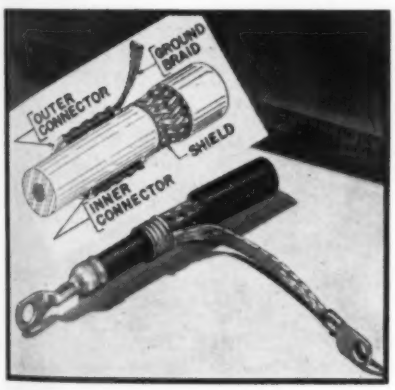
## BEARING MANUFACTURER NAMES EXPORT AGENT

▲ Tyson Bearing Corporation, Massillon, Ohio, manufacturers of tapered roller bearings, has announced the appointment of Borg-Warner International Corporation, Chicago, Illinois, as their sales representatives in all export markets with the exception of Canada and Alaska.

H. L. Vines, director of sales for Tyson, pointed out that by joining the other 18 manufacturers whose products are marketed abroad by Borg-Warner International it will mean a considerable saving to the overseas distributors. Shipments from all concerns will be consolidated at Borg-Warner International's Auburn, Indiana warehouse, then forwarded abroad on a single bill of lading.

## CONNECTORS SIMPLIFY TAPPING AND SPLICING

▲ The making of connections, taps, and splices in coaxial and shielded cable is greatly simplified by the use of connectors designed especially for the purpose and just announced by Burndy Engineering Company. These connectors are new members of the Hydent line, which are installed by indenting with Burndy Hytools. Solder and the possibility of insulation being damaged by heat are eliminated.




The connector for the braided conductor or shield may be installed with a braid tap to make a terminal connection or ground tap, or it may be used merely to anchor the shield to prevent the braid from slipping.

Connection with the inner conductor is made with a Hylug having an insulation shroud. The lug is indented to the conductor, and the shroud crimped to the insulation to form a mechanically strong and moisture-proof terminal.

The outer conductor or shield, as the case may be, is grounded or terminated by a connection which consists of two ferrules and a braided tap which, in turn, is equipped with a Burndy Hylug. The smaller ferrule is slipped between the inner insulation and outer conductor, and is used to take up the pressure when the assembly is crimped. This inner ferrule is required on coaxial and other cables where the inner insulation is of the type that flows under pressure.

The larger ferrule is large enough to accommodate a braid-jumper tap, and is slipped over the outer conductor or shield. The whole assembly is then crimped with interlocking dies. These dies are made to fit a new foot-operated Burndy Hytool, type YIOR.

Splices are made in a similar manner. A Burndy Hylink is used for connecting the two ends of the inner conductors. The braided conductors are spliced by a tubular connector crimped over the two ends; ferrules again being placed under the braid to take up pressure and protect the inner insulation.


*For better steel.. and more of it*

**TELLS YOU AT A GLANCE**

★ AMOUNT OF AIR FLOW AND FUEL FLOW

★ PERCENTAGE OF AIR EXCESS OR DEFICIENCY

**the HAYS VISIO-RATIO GAGE**

IT'S A GOOD "steel man"—this truthful reporter of combustion facts. It's infallible—made to be.

***It saves man hours***—does away with time-consuming calculation of air excess or deficiency and all need for experimental adjustments.

***It saves fuel***—indicates instantly any faulty proportion of air and fuel.

***It saves material***—makes for greater uniformity, and for less spoilage.

It helps you get ***better*** steel—and more of it.

ADVANTAGES

Advantages of Hays centralized control of open hearth furnaces are set forth in Publication 43-586. Useful literature—better send for it.

The HAYS CORPORATION
COMBUSTION INSTRUMENTS AND CONTROL
MICHIGAN CITY, INDIANA, U.S.A.

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HI-LAG

NON-HEATING
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Keep Motors Humming

ARMY E NAVY

APPROVED BY UNDERWRITERS
WARE BROTHERS
4460 W. Lake St. Chicago 24, Ill.

WARE
Renewable
HI-LAG FUSES


## ELECTRONIC SOUND GAUGE ENABLES BLIND TO ACCURATELY GAUGE BEARING PARTS

▲ A new electronic sound gaging device, which may mean employment to thousands of America's otherwise unemployable blind, was given its first public demonstration recently in the factory of The Timken Roller Bearing Company, Canton, Ohio. In the demonstration a sightless operator quickly fed outer races of Timken bearings into an outside diameter gage equipped with the new device at a rate rapid enough to bear comparison with that of a sighted operator.

Shown at the same time was a standard Timken outside diameter gage operated by a sighted employee. The standard gage, equipped with the electronic sound device, made up the blind operator's unit.

Diameters of rolls, cone, and cups, the components of Timken bearings are ground within very close limits of their specified sizes. Each part is then checked for size in the final inspection departments, where the operators use precision gages with electrical or mechanical dial-type indicators. The indicators show highly enlarged (or amplified) readings of any variations in the diameter of the work-piece being checked. Parts with diameters over or under the specified size limit — or out of round — are readily detected and removed.

To enable a blind operator to do this work with the same accuracy, a sound indicator is used on the same type of gage. There is a small, cone-type speaker mounted on the back of the operator's chair and connected with the electronic device. The operator hears three different notes issuing from the loud-speaker. An article that is normal or within the size limit is indicated to the blind operator by the sound of the middle note. This means the article may be passed as meeting the standard. The high note indicates the article is oversize, while the low note indicated that it is undersize. At the sound of either of these notes, the operator rejects the article under inspection.

The three notes are produced by an electronic oscillator which is controlled by relays connected to the three indicator lights of the electronic gaging system. The red, green and orange indicator lights correspond to the three notes of the sound device, the red being high, the green low and the orange middle. Chief purpose of the indicator lights is to give the lineman (who sets up each gage) a

**The cone-type speaker mounted on the inspector's chair emits three different tones to indicate whether the part under test is oversize, undersize or normal.**

quick visual check on the gage's efficiency. The gage is originally set and adjusted to a master gage, and can be made to give both a visual and sound indication as close as one five-millionth of an inch over or under a specified diameter tolerance.

Almost two years were spent in experimenting with various gages before a satisfactory one was found. Manufacturing details of the device — developed by Timken engineers so that the company could give employment to blind civilians and to aid in the reemployment of Timken veterans — will be released without charge to any interested manufacturer.

## FIRE BOMB CASES PRODUCED BY REPUBLIC

▲ Three plants of Republic Steel Corporation have manufactured more than 10,000,000 of the metal cases for the M-69 fire bomb, which is currently wreaking havoc on Japan, for the Pittsburgh chemical warfare procurement district.

As it was impossible to obtain equipment soon enough from outside sources for the initial production of these bombs in quantity, personnel of Republic's Pressed Steel Division, Niles, Ohio, plant early in 1942 built a number of pieces of new special equipment themselves, making use of parts of several old automobiles from the local junk yard and old machine tools which had been ready for the scrap heap and other makeshift devices.

Sample bomb casings were redesigned and repeatedly rebuilt, while tests were being made of the various improvements incorporated. A force of men was kept busy working night and day, Sundays and holidays, rushing out new samples and making frequent flights to the proving grounds to measure the results. When a final design for this bomb was agreed upon Republic's Niles plant immediately began to set up a production line for its manufacture which was in full operation within seven weeks.

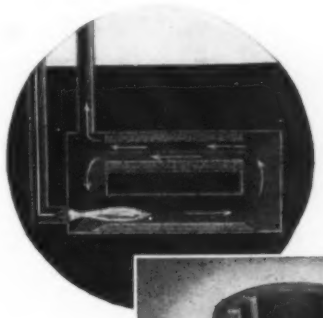
The production line was soon operating on a schedule of 20,000 bomb casings per day, the first million having been produced by March, 1943. Later Republic's Pressed Steel Division plants at Cleveland and Elyria, Ohio, were pressed into service to help make the bomb casings.

## FREE-FLOWING FLUX FOR GAS WELDING ALUMINUM

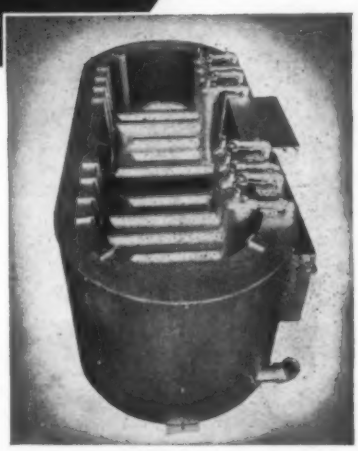
▲ "Flo-Well" No. 1, an improved free-flowing flux for the gas welding of aluminum and aluminum alloys, is now being manufactured by A. K. Mauk, 7583 Hamilton Avenue, Pittsburgh 8, Pennsylvania.

Flo-Well is used to gas weld wrought, cast or high tensile aluminum and aluminum alloys of any size or shape wherever welding is possible. As a result of improved methods of manufacture, Flo-Well will positively not solidify or deteriorate. It can be easily applied by inexperienced welders.

Flo-Well, which is being widely used by the aviation and other industries, is packaged in ¼ lb to 25 lb glass containers to protect the flux from moisture. It may also be purchased in ton lots. Free samples, and instructions for use of this flux, will be forwarded by the manufacturer upon request.

Cross section of Kemp Immersion Heating element showing tubular construction and method of flue gas travel.



*Specify*

**KEMP IMMERSION MELTING** *for*

| | | |
|---|---|---|
| Lead melting | Compound heating | Battery grid casting |
| Tin coating | Stereotyping | Salt baths for annealing |
| Tin melting | Electrotyping | Lead baths for tempering |
| Pewter melting | Solder melting | Lead baths for annealing |

The Kemp IMMERSION MELTER is the standard of industry because of the following features:

1. Heating units are placed inside the metal to be melted—not outside the pot.
2. 40% savings in fuel.
3. Close temperature control increases efficiency, reduces waste.
4. The metal melts faster—cools slower.
5. The pot is insulated, serves only as a container, and does not crack.
6. Reduction in dross formation.
7. Improved working conditions.

For complete information . . . . ASK FOR BULLETIN D-200.1

ARMY E NAVY

Address The C. M. Kemp Mfg. Co. 405 E. Oliver St., Baltimore 2, Maryland

**KEMP PRODUCTS**

Dynamic Dryers (adsorptive dehydrators)
Nitrogen Generators • Inert Gas Producers
Atmos-Gas Producers • Immersion Heaters
Flame Arrestors for vapor lines, flares, etc.
The Industrial Carburetor for premixing gases
Submerged Combustion Burners
A complete line of Industrial Burners, and Fire Checks.

**KEMP of BALTIMORE**

## ARRESTER DESIGN IMPROVES SERVICE RELIABILITY

▲ Pellet-type lightning arresters for the protection of apparatus on distribution circuits 15,000 volts and below, are now of a new design having a separately sealed, nitrogen-filled gap chamber, according to an announcement by General Electric's transformer division, Pittsfield, Massachusetts. Designed to establish a new high in service reliability, this development marks the first use of inert gas in arrester gaps. The dry-nitrogen prevents the formation of ozone or oxides, keeps the gap electrodes bright as new during years of service operation, and gives more stable gap-sparkover characteristics.

In order to eliminate the recognized adverse effects of internal condensation caused by changes in outdoor temperature, all air and atmospheric moisture — usually sealed in the arrester with ordinary manufacturing methods — are completely evacuated from the gap chamber. This process not only excludes the moisture of normal atmospheric humidity from the series gaps of the arrester, but provides an error-proof, vacuum-withstand test of the main sealing of each arrester as well.

After completely evacuating the gap chamber, the dry-nitrogen is injected through a small treating hole in the matal cap which is then immediately solder-sealed. Excluding all oxygen, which is the essential agent for ozone and all forms of oxidation, the injected dry-nitrogen is thus permanently sealed in the gap chamber. It assures an initially moisture-free gap chamber which remains moisture-free through years of continuous operation.

Bulletins GEA-2975 and GEA-4437, available upon request from the General Electric Company, Schenectady 5, New York, contain complete information on the dry nitrogen-filled pellet arresters.

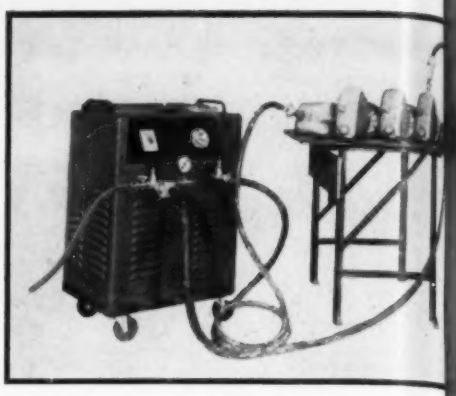
**View showing control valve in position for injecting dry nitrogen into gap-chamber which has been previously evacuated.**

## CASTINGS SALVAGED BY METALLIZING PROCESS

▲ For use in eliminating the costly scrapping of castings rejected because of porosity or pinhole cracks, the Metallizing Company of America, 1330 West Congress Street, Chicago 7, Illinois, has developed the new Mogul Circulator model M-1500 which circulates heated Mogul Cast-Seal solution under pressure through defective castings. Castings which formerly had to be rejected can now be salvaged with this new low-cost method. The pressure-circulated Mogul solution enters the crack at its maximum opening and by the colloidal action of its base quickly builds-up in successive, interlocking layers until a bond which will effectively seal the opening for the life of the casting has been formed.

Foundries now using the Mogul Circulator with Cast-Seal solution have proven the effectiveness of this unit by subjecting to severe tests castings which had been defective but salvaged by the Mogul method. Under pressures as high as 200 psi these reclaimed castings were tested with hot kerosene, hot oil, hot water and many other solutions and it was found that the former porosity and leakage from pinhole cracks had been completely eliminated.

The new circulator is a compact unit mounted on rollers and consists of a sturdily constructed cabinet housing one 15 gal. tank with electric immersion heater, and a turbine-type pump equipped with a $^1/_3$ hp, 110 volt, single phase motor. The 30 gpm capacity pump has an automatic pressure switch which maintains pressure at the setting required by the operator. This automatic pressure switch features a device sensitive to changes in pressure which controls the speed of the pumping action. The operator's pressure setting is thereby assured. Both the immersion heater and the motor are fully protected from overheating by automatic thermal switch. The Mogul Circulator is furnished complete with electrical cable, safety hoses, air pressure gauge, air control petcock and 12 feet of air hose fitted with quick-acting air connector for pressure testing.



**Set-up showing circulator sealing porous castings with Mogul Cast-Seal solution.**

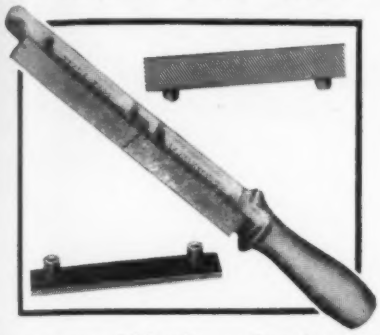
For castings that have large cracks or shrinkage fissures and for castings that would have to be rejected because of blowholes, the manufacturer recommends the Mogul Dot Weld process which has many shop applications and has proven very effective in assuring perfect casting appearance. If the castings are subject to pressures it is recommended that after repair by the Dot Weld process they be serviced with the circulator and Cast-Seal solution to close any remaining porosity. An economy of operation permits the servicing of groups of 2 or more connected castings all at one time.

## LATHE FILES IN IMPROVED MODELS

▲ Kennametal Inc., Latrobe, Pennsylvania announces the development of a new lathe file that retains the advantages of previous models in that it will cut steels no ordinary file will touch, at speeds 3 to 10 times faster than possible with steel files, with a life of 50 to 200 times as long, and in addition provides longer filing surface, quick, easy blade replacement, and greater handling convenience.

In this new design, the Kennametal blanks have brazed-on nuts, as shown

in the insets on the illustration, and are attached to the light-weight aluminum alloy handle by screws. They can therefore be readily replaced when worn, from long service.



Two types of blanks — fine (30 teeth per inch) and coarse (20 teeth per inch) — are available, and are interchangeable on the same handle. The handle grip is shaped to fit the hand, and has a thumb rest and knuckle guard. An extension beyond the filing surface supplies a convenient finger hold. A hole in this extension permits the file to be hung up.

One size is now available — the F-45, 13½ in. long overall — with a filing surface ¾ in. x 8 in. long comprising two ¾ x 4 in. Kennametal blanks.

### WHEELING TO REBUILD HOT STRIP FURNACES

▲ Contract for the reconstruction of three hot strip mill furnaces at the Steubenville, Ohio, works of Wheeling Steel Corporation has been awarded to Rust Furnace Company, Pittsburgh, Pennsylvania. The furnaces, serving one of the early strip mills built in the country, were originally built by Rust.

### FURNACE BUILDER MOVES OFFICES AND PLANT

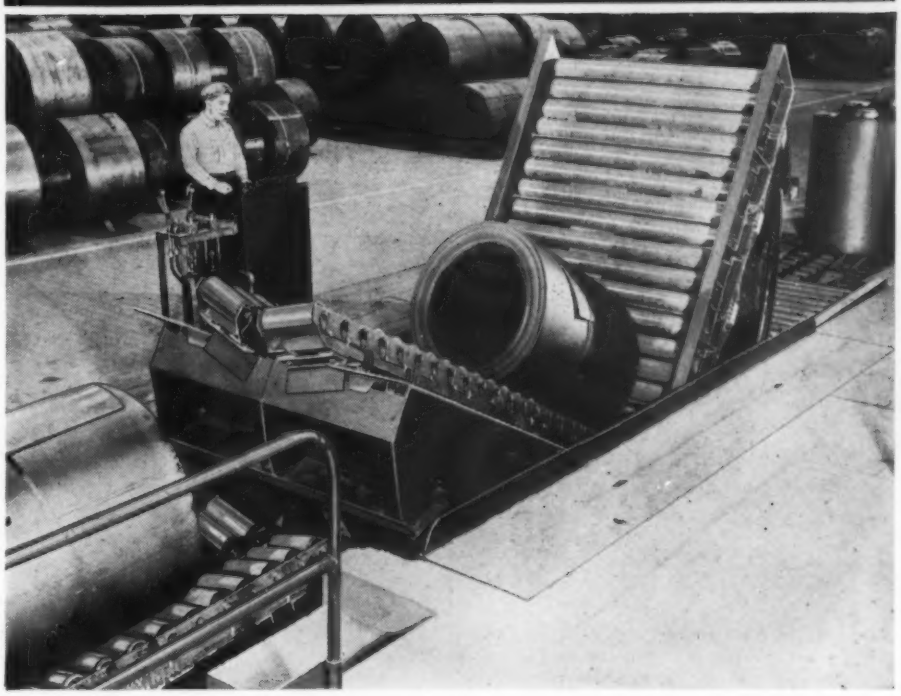
▲ Tate-Jones and Company, Inc., manufacturers of industrial furnaces and auxiliary equipment for the heat treating of metals, has announced the removal of its executive, engineering and sales offices from Leetsdale, Pennsylvania, to the Plaza building in downtown Pittsburgh.

In conjunction with this change, the plant will be moved from Leetsdale, where it has been located since 1898, to Beaver Falls, where greater space and better facilities are available. The new plant will give the corporation the advantage of having one of the largest shops among the few furnace companies who maintain their own fabricating plants.


# Mathews

## COIL HANDLING CONVEYERS

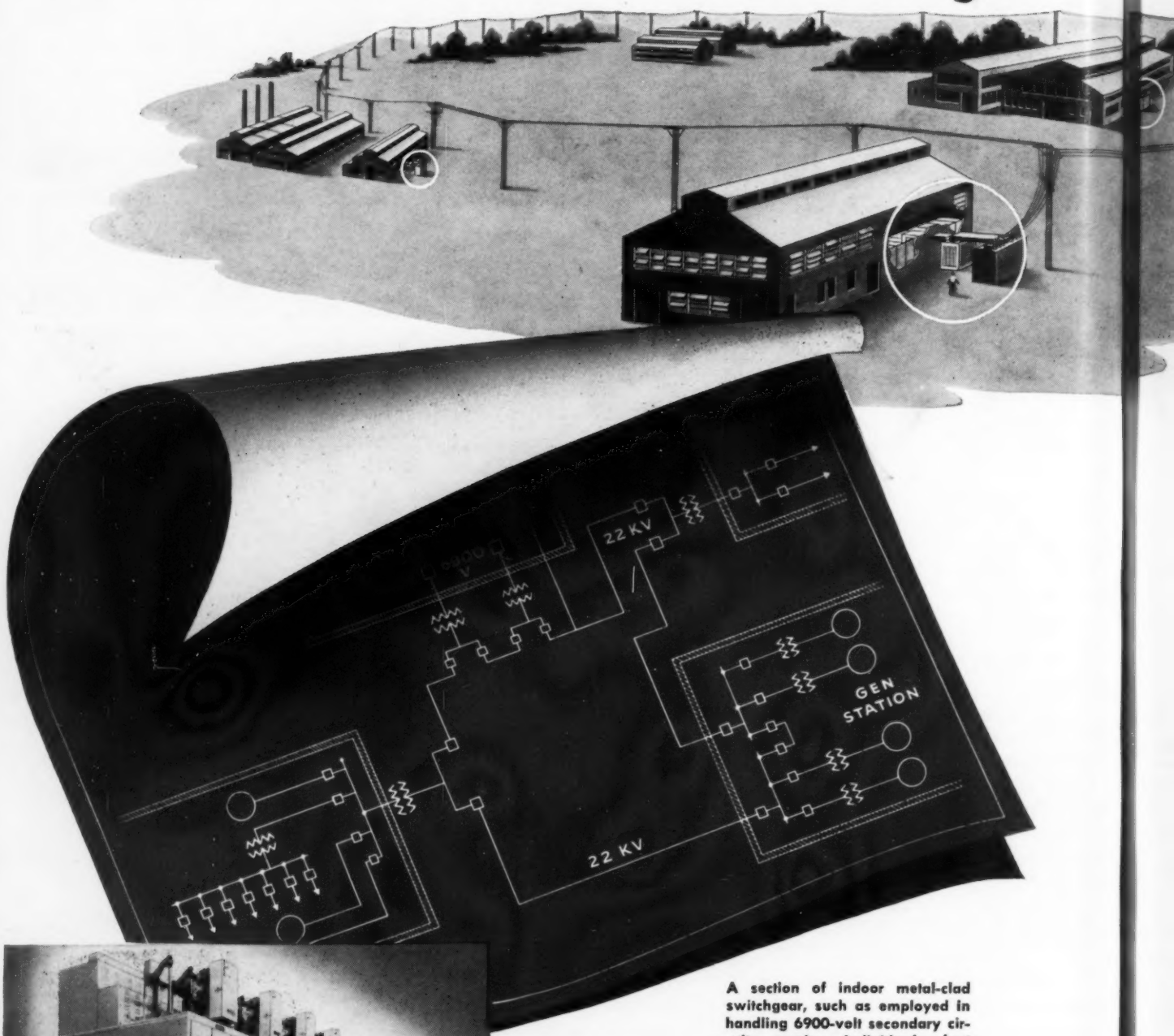
*Engineered to serve Production*



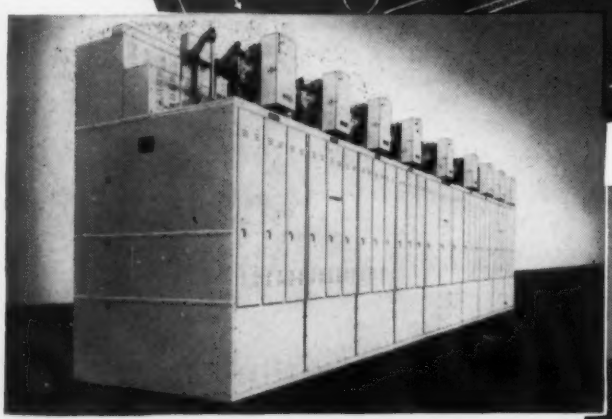
**Mathews Engineers have accumulated many years of experience in the development of coil-handling conveyers. This concentrated effort has resulted in high-quality up-enders and down-enders, combination up-enders and side tilters, troughed roller conveyer, turntables, and tail pullers. There is a Mathews Engineer operating in your vicinity. He will be glad to show you what has been done in the handling of steel, brass, and aluminum coils. He will also give you data concerning the many other types of Mathews Conveyers which have been engineered to serve production.**

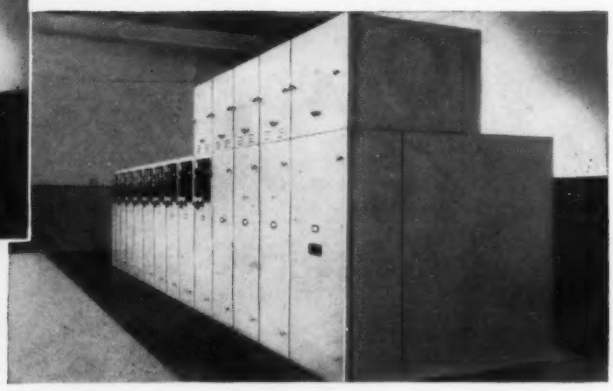
MATHEWS CONVEYER COMPANY
ELLWOOD CITY, PENNSYLVANIA
SAN FRANCISCO, CAL. • PORT HOPE, ONT.
ENGINEERING OFFICES IN PRINCIPAL CITIES

# For New Flexibility



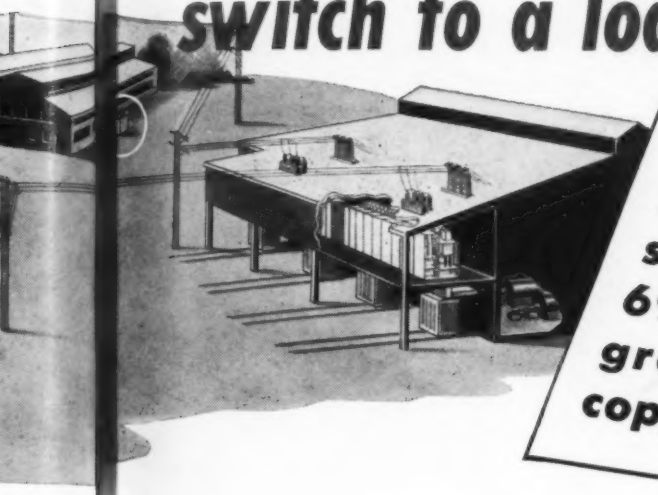

A section of indoor metal-clad switchgear, such as employed in handling 6900-volt secondary circuits serving individual plant areas and high-voltage drives.





For circuit-breaker service up to 23,000 volts, these modern FH cubicles assure extra safety without complexity. In addition to indoor assemblies, such as shown above, this compact factory-assembled switchgear is available in outdoor enclosures.

# IN BIG-PLANT POWER SUPPLY
## *switch to a load-center system like this*



**Power distribution over 22-kv loop, to "power islands" serving individual buildings at 6900 volts, simplifies load growth — cuts distribution copper by two-thirds!**

Here's a proposal for big-scale power distribution that shows how you can break away from conventional practices that complicate tomorrow's plant or power-system growth. The over-all installed cost is low—*and definitely predictable.*

In the past, many plants selected, for their generation and distribution voltage, the highest utilization voltage required anywhere in the plant—say 6900 volts. The system expansion was continued at this level. As electrical usage everywhere increased (perhaps from 10,000 to 100,000 kva or more), feeder conductors demanded greater and greater investment. Switchgear was menaced by short-circuit currents beyond the practical interrupting capacity of power circuit breakers at this voltage.

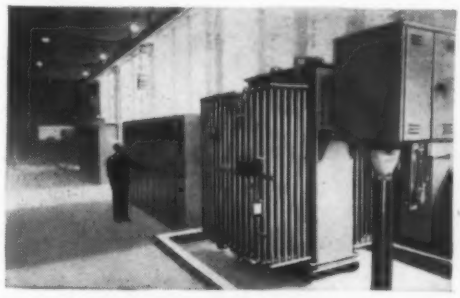
### *LOOP SYSTEM BRINGS FLEXIBILITY*

This system plan calls for stepping up voltage at the generating plant to 22 kv, and distributing it over a high-capacity loop. Utilization substations (circled in sketch above) have transformer capacity matched to the actual power demand of particular buildings or operating areas. The investment tied up at any one particular spot is held within reasonable limits *without adding greatly to costs of meeting new loads.*

### *STANDARD EQUIPMENT CUTS COST*

"Packaged unit" installations of G-E load-center substations (using the justly famous Type FH high-voltage circuit breakers in standard cubicles) help cut the cost of this system, and save engineering and installation time. They greatly simplify relocation, should plant changes require it.

Now that cost reduction is again taking top place in evaluating steel-mill capital expenditures, why not check with G.E. for facts and figures on power-system modernization? *General Electric Co., Schenectady5, N.Y.*



**G-E load-center unit substation with 2.4-kv secondary. Other substations serve 600-volt loads.**

**BUY ALL THE BONDS YOU CAN—AND *KEEP ALL YOU BUY***

**GENERAL ELECTRIC**

**LOAD-CENTER POWER DISTRIBUTION SYSTEMS**

# New Literature

▲ "Steel Expansion for War," by W. A. Hauck, Steel Division, WPB, is a 192 page book, 8¼ x 11 inches and well illustrated, presenting an official historical report of the steel expansion program. Data are presented on the facilities installed or rebuilt by some 3000 companies, together with details on type of products, cost and added capacity. Penton Publishing Company, 1213 West Third Street, Cleveland, Ohio; $2 postpaid.

▲ "Chemistry for Electroplater" by C. B. F. Young, sets forth in clear, simple language the chemical theories and definitions having a bearing on electroplating. Assuming no previous knowledge of chemistry, the book is designed for men in electroplating work who desire to obtain a working knowledge of the chemistry of the process. Chemical Publishing Company, Inc., Brooklyn, New York; 205 pages; $4.

▲ Just published by Askania Regulator Company is a 16 page booklet (Technical Paper 100) titled "Process Control Terms." The booklet was prepared by H. Ziebolz to supplement the work done by the Terminology Committee of the Industrial Instruments and Regulators Division of the American Society of Mechanical Engineers. In 45 sketches the proposed definitions are interpreted in such a manner as to clarify the written words. Originally put together for Askania engineers, the booklet will be of considerable value to anyone who specifies, purchases or applies control instruments. Copies may be obtained from the company at 1603 South Michigan Avenue, Chicago 16, Illinois.

▲ A new bulletin published by Morganite Brush Company, Inc., describes the company's line of carbon seals and rings as used compressors, turbines, pumps, meters, etc. It can be obtained upon request to the company at Long Island City 1, New York.

▲ "Corrosion Resistant Materials and Equipment" is a 16 page booklet which describes various products of U. S. Stoneware Company, Akron, Ohio. Included are plastic compounds, tanks and lining materials, tubing, gasketing, paint, chemical stoneware, masonry, mixing equipment, towers and tower packing. Complete characteristics and application data are given. Copies on request to the company.

▲ Wagner Electric Corporation, 6483 Plymouth Avenue, St. Louis 14, Missouri, has recently issued a 16-page folder (form GU-86) describing briefly its entire line of electrical and automotive products: motors, transformers, industrial brakes and controls, hydraulic brakes, air brakes, tachographs (speed-recording speedometers), NoRoL, brake lining, and brake-service tools. Also included are pictures and addresses of Wagner's 29 sales and service offices, and an airplane view of the factory.

▲ To provide an understanding of the principles of electronics and an idea of the part electronics will play in future industrial developments, a 20 page book entitled, "Introduction to Electronics," has been produced by the Allis-Chalmers Manufacturing Company. The new educational bulletin was prepared by Dr. Walther Richter, recognized as one of the outstanding engineers in this promising electrical field.

A brief discussion on the fundamentals of conversion and control of electric power in a load prefaces introduction of the subject of electron tubes. Approaching this subject as a guide for application engineers, instead of tube designers, the book explains that the electron tube is a new control element which is nothing but a special type of rheostat or switch. The discussion of tubes is divided into two main parts: Vacuum and gaseous.

Differences between a vacuum tube and the equivalent mechanical device, methods of specifying tube performance, application of tube characteristics for design purposes, and use of the high speed response of the tube are explained. Clearly presented are principles of tube detector action with applications, and principles of tube oscillators with application to induction and dielectric heating. Line drawings, curves, and sketches add materially to comprehension.

This booklet, E6358, is available upon request from the Allis-Chalmers Manufacturing Company, 568, Milwaukee 1, Wisconsin.

▲ A new catalog, "Haynes Stellite Metal-Cutting Tools," which describes the high-production metal-cutting tools made from Haynes Stellite 98M2 and Star J-Metal alloys, has just been published by Haynes Stellite Company, a unit of Union Carbide and Carbon Corporation.

The catalog includes descriptions, illustrations, engineering drawings, specifications, and prices for standard tools manufactured by the company. Among the tools discussed are square, rectangular, and round tool bits; boring and reaming blades; tipped tools and tool tips; grooving tools; cutoff tools; insert milling cutter blades; shell end mills; wear strips; and special tools. To aid those using Haynes Stellite tools, the booklet includes recommendations for cutting angles, speeds and feeds for turning, boring and milling various plain and alloy steels, cast steel and cast iron, stainless steel, bronze, brass and aluminum. Full recommendations are also included covering paper grinding, brazing and silver soldering techniques.

The attractive 52-page booklet is conveniently punched for binding, and is completely indexed for convenient reference. Copies are available without charge or obligation from the general offices of Haynes Stellite Company, Kokomo, Indiana.

▲ A new catalogue, containing design and operating features of precision engineered Fox Hi Speed swing frame grinders, has just been issued by Fox Grinders, Inc., Pittsburgh, Pennsylvania. A detailed description of the complete line of Fox grinding equipment is available.

Fox Grinders are designed for almost every type of industrial need and include the No. 4, for heavy duty grinding of large slabs, heavy gates and risers; No. 6-4, for foundry work; No. 6, general purpose grinder for foundries or steel mills; No. 8, for grinding small billets and forgings; No. 10, light and maneuverable for iron foundries.

Details of the Fox Hi Speed stand grinder, which is available in four sizes, are fully outlined in the new catalogue. Its simplicity of design and rugged construction, plus the outstanding features of type of wheel mounting and bearing construction, provide for long life and efficiency.

Included also is a description of the Fox swing frame abrasive belt grinder, which represents a new approach to

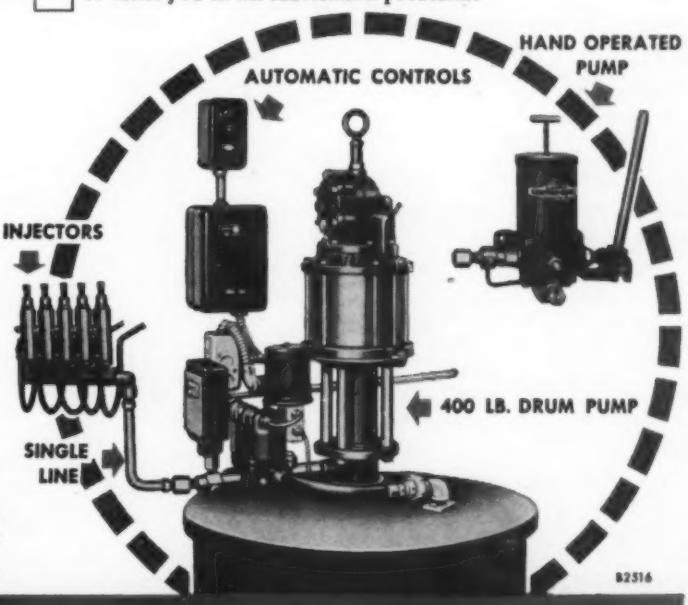
# To Those Responsible for Maintenance... facts-- about LINCOLN Single Line CENTRO-MATIC LUBRICATING SYSTEMS

**The demand for efficient and unfailing production has emphasized the need of adequate lubrication methods for plant machinery and equipment.**

**Today's accelerated pace has brought out the inadequacies of the older, time-consuming methods of lubrication and the importance of investing in positive centralized lubricating systems.**

**Everyone responsible for the maintenance of plant machinery and equipment should investigate the outstanding merits of Lincoln Centro-Matic Lubricating Systems. A few facts are given below—**

1. Lincoln Centro-Matic Systems will dispense either oil or grease.
2. Will dispense a pre-determined, measured quantity of lubricant, unaffected by temperature or viscosity changes.
3. Lubricant is delivered through an injector to each bearing at maximum line pressure regardless of location on the machine.
4. Injectors are easily adjusted for the desired output—no special tools needed.
5. Each injector is provided with an external indicator.
6. A complete range of lubricant pumping units adaptable to the bearing requirements of a single machine or a battery of machines. Pneumatically, electrically or manually operated.
7. Centralized or zoned systems pumping lubricant from an original refinery container and supplying lubricant automatically at fixed time intervals.
8. All pumping units are of proven design and incorporate features that have been used on Lincoln lubricant pumps that have served dependably in automotive, agricultural and industrial applications.
9. Systems can be installed so that lubrication can be effected by the operator either by operating a manual pump, opening a valve on a common lubricant line under pressure, or from a time-controlled central source
10. Easy to install. Only one supply line is needed.
11. Any injector in a manifold can be removed for inspection without disturbing line connections or other injectors in the manifold.
12. Special Linpak packing eliminates metal-to-metal seals. This maintains accuracy and gives longer service life.
13. The facilities of Lincoln Engineering Company are devoted exclusively to the manufacture of lubricating equipment.
14. A staff of experienced lubrication engineers is ready to assist you in all lubrication problems.




✓ *Check these facts* — **compare them with other systems and you will understand why Lincoln Centro-Matic Systems are being used in all types of industrial applications. Write for literature today.**

ARMY E NAVY

**LINCOLN ENGINEERING COMPANY**

*Pioneer Builders of Engineered Lubricating Equipment*

5701 NATURAL BRIDGE AVE., ST. LOUIS 20, MO., U. S. A.

LINCOLN

grinding problems in the fabrication field.

Copies of the new catalog may be obtained through this publication or by writing direct to Fox Grinders, Inc., Oliver Building, Pittsburgh 22, Pennsylvania.

▲ To acquaint coated abrasive users with the newly announced system for identifying coated abrasives by Carborundum, The Carborundum Company has prepared "Sanding and Finishing," an 84-page book containing information about coated abrasives, including — a complete explanation of the new system and new end use names for all coated abrasive products. Also there are comprehensive recommendations for the use of coated abrasive products in metal-working, wood-working, shoe and leather, floorsanding, printing, plastics, pipe and hat trades, specifications for belt sanding, belt splices and speeds.

"Sanding and Finishing" is available to all bonafide industrial users of coated abrasives upon request on business letterhead to The Carborundum Company, Niagara Falls, New York.

▲ Youngstown Steel Car Corporation, Niles, Ohio, has issued a new 32-page, illustrated catalog on facilities and products. The subjects include hot and cold stamping; hand and automatic welding; inspection; heat treating and finishing; machining; engineering and designing. Products include: automotive bus, truck and trailer chassis parts; die pressed channels; weldments; tunnel liners; railway cars, repairs and repair parts.

▲ A new 24-page, two-color booklet, "Oxygen — Indispensable Servant of Industry," profusely illustrated and fully telling the interesting story about oxygen — how it is made and how it is used in industry — has been published by Air Reduction.

Photographs and text tell how 99.5 per cent pure oxygen is guaranteed users and why this higher oxygen purity assures greater economy and maximum end-use efficiency of the product.

Other explanatory sections describe the different types of "packages" for varying oxygen volume requirements, operating conditions, and internal plant gas distribution methods. Also treated is Airco's applied engineering service for helpful technical and on-the-job assistance. Descriptions of hand and mechanical welding, flame hardening, flame cleaning, underwater cutting, hand and machine gas cutting and other flame processes developed or perfected in Airco's research laboratories are included along with photos of apparatus, accessories and supplies and other technical literature.

Copies of the booklet, No. ADG-2014, are available on request from Air Reduction Sales Company, 60 East 42nd Street, New York 17, New York, or any local Airco office.

▲ A new 8-page technical article, "Salt Baths for Process Annealing, Cyclic Annealing and Descaling," describes the principle of immersed electrode type salt bath furnaces and cites three actual installations. The application of this equipment, processing methods, temperature-time cycles, floor area and cost figures are given. In addition, the article is enhanced by many installation photographs as well as graphs.

Those engaged in drawing, rolling, extruding, forming and fabricating of wire, rod and strip will find the article


**It's new! It's heavy duty! It's raintight!**

Type WMKS **Interlocking** Safety Switch and Plug Receptacle

**CONDULET**

*(CONDULETS are made only by CROUSE-HINDS)*

for the control of portable electrical equipment in **both** indoor and outdoor locations.

**Safety.** Positive interlock prevents opening the case or withdrawing the plug unless the switch is "off". Switch can't be turned "on" unless the case is closed and the plug fully inserted.

**Switches.** Motor circuit switch. Quick make and break. Double break, reinforced, positive pressure-type blade and jaw construction. Positive pressure fuse clips. Combination solder or solderless wire lugs 2 or 3-pole fusible.

**Plug Receptacles.** Style I is grounded through the shell. It will take the plugs used with the former Type MKS of the same rating. Style II is grounded through an extra pole and the shell. An eyebolt and wingnut prevents accidental withdrawal of the plug when the switch is open.

**Cast metal case.** Strong and durable. Four sturdy mounting feet. Many possible threaded hub arrangements for both vertical and horizontal conduit. Cover may be padlocked to prevent unauthorized entry. Operating handle may be padlocked "on" or "off".

**Threaded operating shaft.** Bearings permanently lubricated to resist corrosion and prevent the entrance of dust and moisture.

**Horse-power ratings.** 2 through 50 H. P.

30, 60, 100 or 200-ampere. 230 or 575 Volts A. C.

*Listed in Condulet Catalog No. 2500, Section 50, Pages 21 and 22*

Type WMKS Interlocking Safety Switch and Receptacle Condulet with Type DP Interlocking Plug

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of interest and may obtain a free copy upon request to Ajax Electric Company, Inc., Frankford and Delaware Avenues, Philadelphia, Pennsylvania.

▲ Because its various pioneering personnel practices have attracted so many inquiries from business executives, the Ilg Electric Ventilating Company of Chicago, Illinois has compiled a booklet to answer such requests for information which outlines the historical development and results of its employee policies.

Entitled "ILG Welfare Club — Policies and Personnel Practices of the Ilg Electric Ventilating Company," the twelve-page booklet starts out with the innovation in 1907 of the Ilg profit-sharing plan and length of service bonus. A liberal vacation policy for both office and shop employees was initiated the same year. Five years later came the company cafeteria.

Other innovations followed through ensuing years, culminating with the initiation of a retirement annuity in 1939 to supplement social security payments to retired workers, and a hospitalization plan for the entire family in 1942.

Complete details of these and other practices pioneered by Ilg are detailed in the new booklet. Copies may be secured direct from the home office at 2850 North Crawford Avenue, Chicago, Illinois, or from any of the Ilg branch offices located in principal cities.

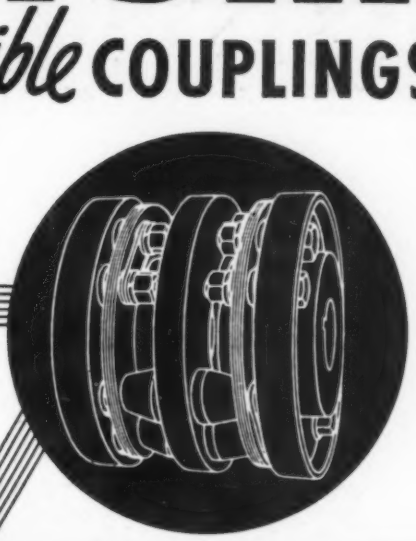
▲ Precision Equipment Company, industrial equipment distributors at 32 North State Street, Chicago, Illinois, have published an Industrial Buyers' Bulletin listing equipment ordinarily difficult to obtain but which this firm has in stock for immediate delivery. The booklet is designed to acquaint industrials with various types of equipment available for improving production, inspection and research facilities. Net wholesale prices are shown for all items, among which are included steel tool room units, fans, slide rules, micrometers, counting scales, time switches, inverters, grinding tools, tool chests and wire strippers. This bulletin is offered free of charge to engineers, purchasing agents, and to other industrial executives.

▲ A new 83-page booklet "The Milling Machine and its Attachments," has just been published by the Kearney and Trecker Corporation of Milwaukee, Wisconsin. This is book 2 in the milling practice series being published by this company. Divided into nine chapters, it covers the knee and bed types of milling machines, their attachments, and their operation. Copies of this booklet are available on request.

▲ A new edition of its catalog section on the properties of Ameripol D, an oil and heat resistant synthetic rubber which it developed for specialized applications, has just been published by The B. F. Goodrich Company, Akron, Ohio and is now available upon request.

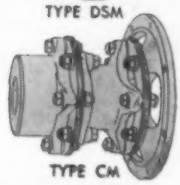
Properties of Ameripol D are outlined in detail. One of the features is a page table giving the property relation of natural and various types of synthetic rubber. Other tables list the properties of typical commercially available Ameripol D compounds, the per cent volume increase after 48 hours immersion in oil of natural rubber and the various types of synthetic rubber, and a guide to determine where the use of Ameripol D is practical. The section is illustrated with Ameripol D products of various types.


THOMAS
Flexible COUPLINGS

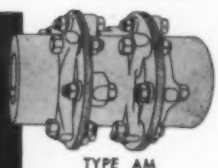


TYPE DBZ

TYPE DSM

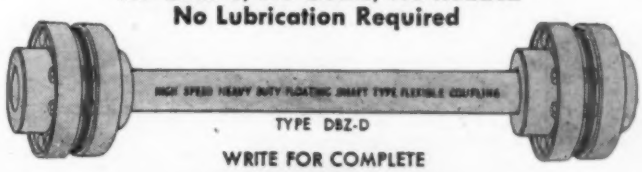

TYPE CM

Eliminate BACKLASH, FRICTION, WEAR AND CROSS-PULL
the four destructive evils of other types and makes of couplings that prevent a permanent care-free installation.


TYPE AM

TYPE-MT

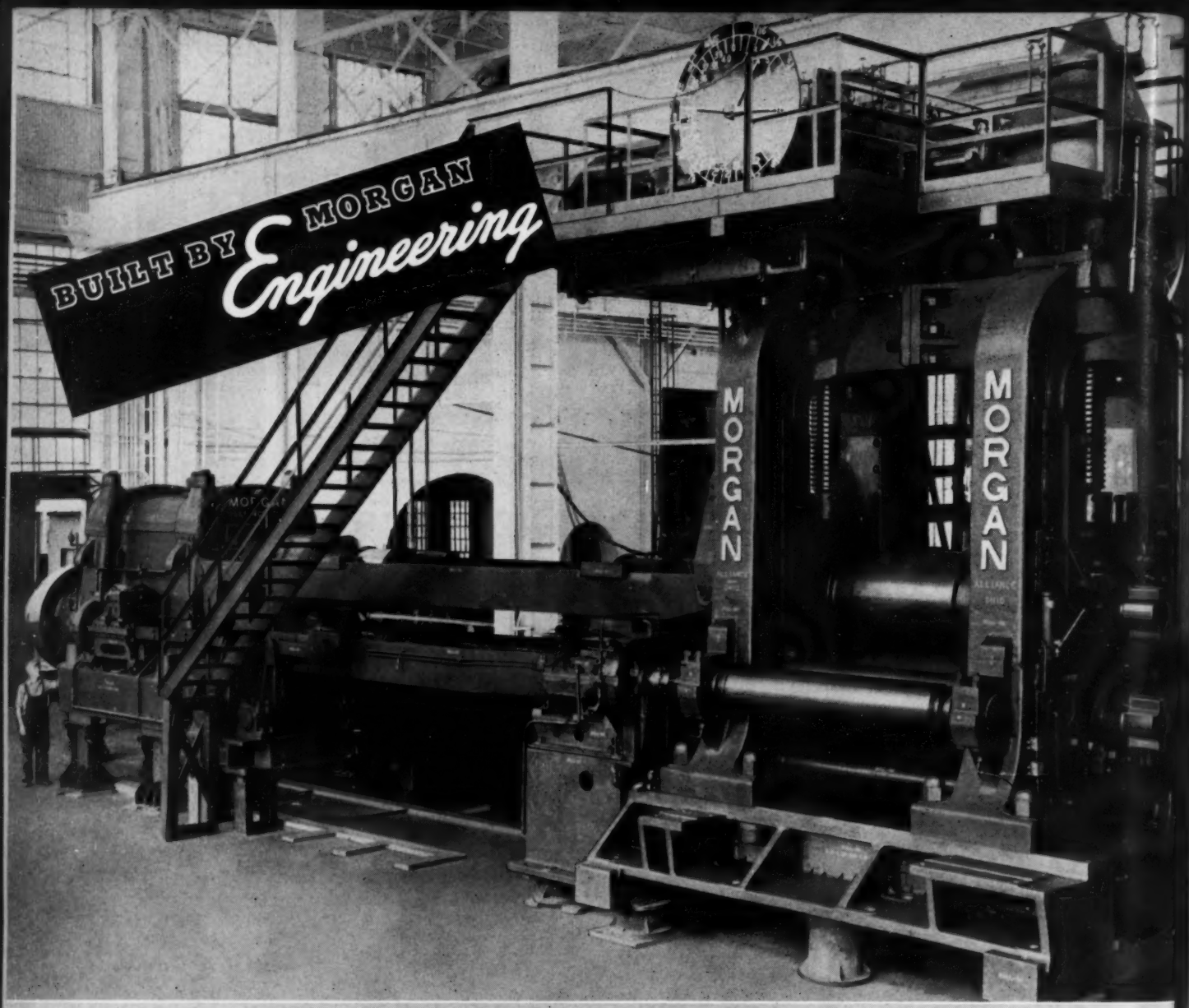
The Thomas All-Metal Coupling has:
No Chains, No Gears, No Rubber.
No Lubrication Required


TYPE DBZ-D

WRITE FOR COMPLETE ENGINEERING CATALOG

TYPE SS

THOMAS FLEXIBLE COUPLING CO.
WARREN, PENNSYLVANIA




## MORGAN "36" TWO-HIGH BLOOMING MILL

Above is shown a Morgan 36" Two-High Blooming Mill on erecting floor. Housings are one piece steel castings of the closed top type. Top roll balance is of the counterweight type. Top roll lift sufficient for rolling 42" wide slabs. Manipulator is of the overhead type, compact and accessible. Tables are of heavy design, equipped with anti-friction bearings.

With this Mill was furnished Auxiliary Equipment as follows — Front and Rear Tables with Manipulator — Approach Table — Ingot Buggy — Runout Tables — Slab Shear with Gauge — Crop Hoist — Pushers — Conveyor — Skid Bed and Furnace Tables.

**THE MORGAN ENGINEERING CO.**

ALLIANCE, OHIO. 1420 Oliver Building, Pittsburgh

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# Personnel News

**J. S. Murray,** chief electrical engineer for Follansbee Steel Corporation, has resigned to become Pittsburgh sales manager for the Alliance Machine Company, Alliance, Ohio. Educated at Carnegie Institute of Technology and in the students course at Westinghouse Electric and Manufacturing Company, Mr. Murray was employed by Westinghouse in the research and sales department and in 1918 entered consulting engineering work.

He entered the employ of Follansbee in 1919 as field manager in charge of the electrification of the Toronto, Ohio, plant. For the past 15 years, in addition to his regular duties as electrical engineer, he has supervised the production and sales of silicon electrical steels.

Mr. Murray has long been active in the Association of Iron and Steel Engineers and was this year serving as first vice president. He is also a member of the American Institute of Electrical Engineers, the American Society for Testing Materials, and the American Iron and Steel Institute, and has served on many committees in these organizations.

**W. H. Williams** was elected president of Clark Controller Company, Cleveland, Ohio, at the regular monthly meeting of the board of directors of the company July 19th. Familiarly known as "Pete" to his hundreds of friends in the steel industry, he had served for many years as vice president in charge of sales, and for the past year as executive vice president and general manager.

With **P. C. Clark,** who died July 8, 1944, Mr. Williams was one of the founders of the company, and has spent 35 years in the electrical control industry. He is a graduate in electrical engineering of Drexel Institute, Philadelphia, a member of the Association of Iron and Steel Engineers, and is chairman of the advisory committee of the Industrial Control Section of the National Electrical Manufacturer's Association.

**Fred E. Harrell,** chief engineer of Reliance Electric and Engineering Company, Cleveland, Ohio, for the past two years, has been appointed general works manager, succeeding **S. B. Taylor,** who has resigned as manufacturing vice president but will remain a member of the board of directors. **William R. Hough,** product development engineer, has been named chief engineer succeeding Harrell.

For a year prior to his appointment in August 1943 as chief engineer, Mr. Harrell served with marked success as executive director of Reliance's new Marine Division plant on East 152nd Street. His recall to the engineering department at that time was in response to the greatly increased demands made by the war on the company's engineering staff.

A native of Logansport, Indiana, Mr. Harrell came to Reliance in 1924 upon graduation in electrical engineering from Purdue University. In 1927 he was transferred from sales engineering in the company's Chicago office to general engineering in Cleveland. For nine years, from 1934 to 1943, he served as assistant chief engineer.

Mr. Hough was born in Kalamazoo, Michigan, and joined Reliance in 1929, following graduation in electrical engineering from the University of Michigan. Prior to his work on product development he had served successively as junior engineer, chief draftsman, and alternating current design engineer.

**C. W. Guyatt,** formerly chief industrial engineer of American Steel and Wire Company, has been appointed assistant to **C. D. King,** chairman of operating committees for United States Steel Corporation of Delaware.

A graduate of Lehigh University with a degree in electrical engineering, Mr. Guyatt began his business career in 1929 with the Public Service Corporation of New Jersey. He joined the American Steel and Wire Company in 1935 as industrial engineer at Worcester, Massachusetts. Progressing through various positions, he was made chief industrial engineer of the company in 1942, the post he leaves for his present appointment

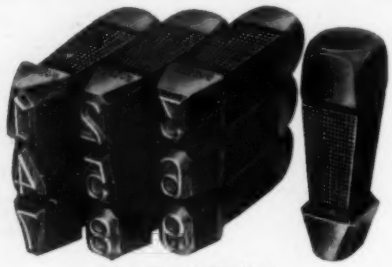
Mr. Guyatt will be located in Pittsburgh and wil

J. S. MURRAY

W. H. WILLIAMS

FRED E. HARRELL

**SAFETY** (REG. TRADE MARK) **Wedge Grip**
**LETTERS and FIGURES**



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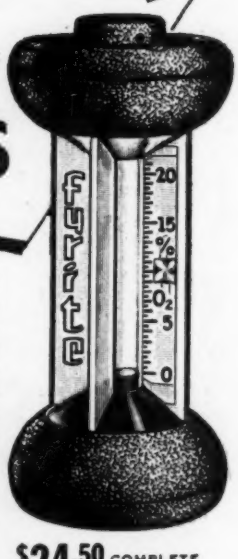


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assist Mr. King in the establishment of production standards for all U. S. Steel subsidiary manufacturing companies.

**A. C. Fellinger** has been named sales manager of power transmission machinery, for Link-Belt Company, with headquarters at the company's Ewart plant in Indianapolis. This change is made to fill the vacancy caused by the death of **C. Walter Spalding.**

Mr. Fellinger joined the Link-Belt organization at Indianapolis in 1916. His last position was manager of sales through distributors, with headquarters in Chicago.

**H. F. R. Weber** will hereafter head up the sale and application of Link-Belt silent chain drives with headquarters at the Ewart plant. Mr. Weber started his Link-Belt career at the company's Philadelphia plant in 1915 as a power transmission engineer, and last held the position of central division manager for power transmission machinery, with headquarters in Chicago.

**G. H. Woody** continues as sales manager of the Link-Belt ball and roller bearing division, with headquarters at the bearing plant in Indianapolis.

**F. A. Hurd** will supervise sales through Link-Belt distributors in Chicago and **G. H. Unruh** in Philadelphia.

**Gilbert Soler,** superintendent of the quality control departments at Steel and Tube Division of the Timken Roller Bearing Company, has been named assistant general superintendent of the division.

Starting with the company in 1931 as a refractories engineer, Mr. Soler was made manager of research in 1934 and in 1937 was promoted to manager of research and mill metallurgy, which position he held until 1943, when he became superintendent of quality.

Mr. Soler attended elementary and high schools at Columbus, Ohio, and was graduated from Ohio State University in ceramic engineering in 1930.

He was awarded an Experiment Station fellowship for graduate work leading to a master's degree at the university the next year, and in 1940 received a professional degree in metallurgical engineering there.

**Richard T. Nalle,** for the past twenty years vice-president in charge of operations of Henry Disston and Sons, Incorporated, was elected executive vice-president of The Midvale Company, a newly-created post, effective October 1st. He also was elected a director of Midvale.

Mr. Nalle has resigned his post with the Disston Company, where, among other things, he has had charge of production of armor plate for military tanks. He continues, however, as a director of the Disston Company.

He is also a director and member of the executive committee of The Baldwin Locomotive Works, a vice-president of The Franklin Institute and an industry member of the Regional War Labor Board.

Mr. Nalle is a graduate of Haverford School and the University of Pennsylvania, where he received a bachelor's degree in electrical engineering.

**E. J. Garrigan,** formerly vice-president and factory sales manager, has been appointed vice-president in charge of sales and will be responsible for directing all sales activities of The Okonite Company and its Hazard

Insulated Wire Works Division, as well as those of its affiliate, The Okonite-Callender Cable Company, Inc. Mr. Garrigan, also a director of the company, joined the Okonite organization in 1924 and has been connected with the electrical wire and cable industry for over 40 years. He will be located at the company's executive offices in Passaic, New Jersey.

**C. E. Brown, Jr.,** formerly vice-president in charge of Okonite's Washington, District of Columbia, office has been appointed vice-president and general manager to coordinate the activities of the executive offices in Passaic, New Jersey with the company's 18 branch offices. Mr. Brown, who will have offices at Passaic, New Jersey, as well as in the New York district sales office, has been connected with the Okonite sales organization since 1919, first as an agent with the Central Electric Company of Chicago, and later as manager of Okonite's power and light department in the Chicago territory.

Mr. Brown will also take over the duties performed by the late W. K. Vanderpoel in acting as a contact executive between the officials of the power and light utilities and Okonite's utility specialists in branch offices.

HARRY A. FELDBUSH

**Harry A. Feldbush,** formerly works manager of the Holyoke, Massachusetts, plant of Worthington Pump and Machinery Corporation has been named vice president in charge of engineering for the entire corporation. His new duties cover engineering activities of all works and domestic subsidiary companies. His headquarters will be at the general offices in Harrison, New Jersey.

**Ralph N. Watson,** formerly chief engineer af the Centrifugal Engineering Division has been appointed assistant to Mr. Feldbush.

**Dan A. Farrell** has been appointed supervisor of safety for Carnegie-Illinois Steel Corporation. Mr. Farrell, a graduate of the University of Illinois, started with the company as an industrial engineer in the South Chicago plant in 1937, later becoming plant industrial engineer. He was promoted to foundry superintendent in 1940, holding this position until his present appointment. Previously he had been associated with various Chicago companies in a supervisory capacity.

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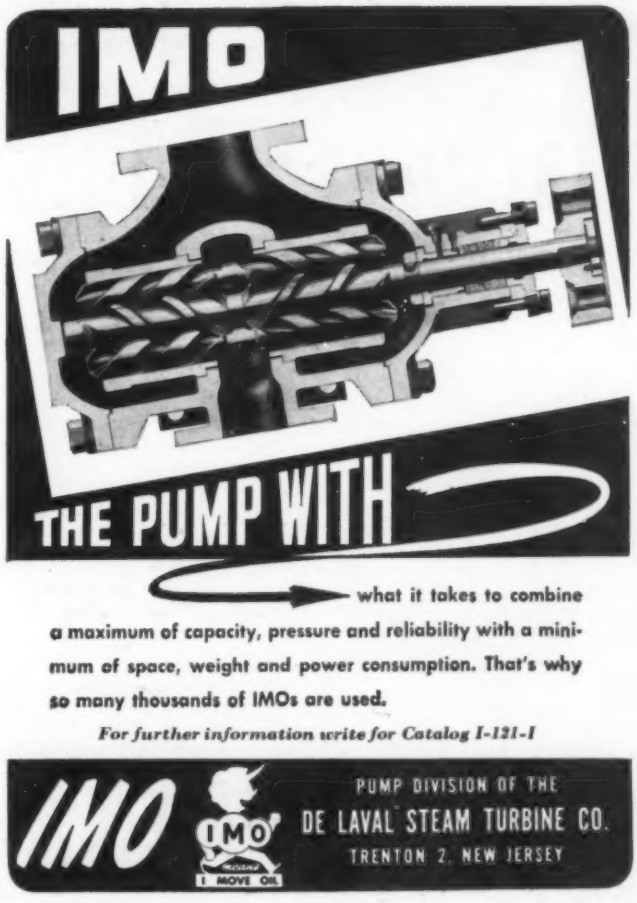
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**Don H. Krey** has been made sales manager, and **Elliott G. Johnson** assistant sales manager for Homestead Valve Manufacturing Company, Coraopolis, Pennsylvania. Mr. Krey will direct all phases of the company's sales efforts, including valves, Hypressure Jenny steam cleaners, and Hypressure Jenny compuond sales and research. Mr. Johnson will supervise all valve sales activities in addition to retaining his duties as director of advertising and public relations.

**R. L. Miller** has been appointed sales manager for Norma-Hoffman Bearings Corporation, Stamford, Connecticut. At the same time, **E. M. Beers, Jr.,** and **G. V. Titsworth** were made assistant sales managers, **C. L. Brown, Jr.,** assistant to the sales manager, and **W. G. Sargent,** manager of distributors sales.

**R. S. Keeler** has been appointed sales manager for Delta-Star Electric Company, Chicago, Illinois. Mr. Keeler has had ten years experience in the sale of Delta-Star equipment, following many years experience with a large utility. For many years he worked out of the Chicago office and for the past few years he has managed the New York office.

**John Romano** newly appointed assistant sales manager, has been with Delta-Star for many years, coming up to the sales department from the engineering department.

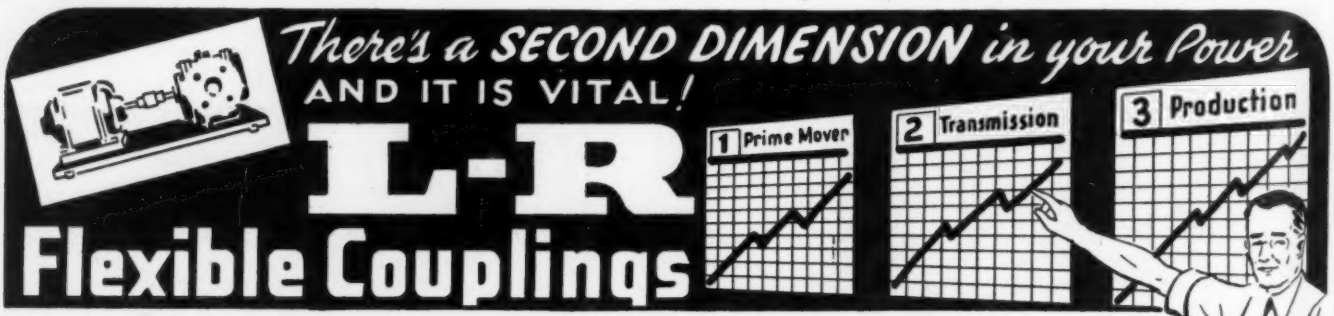
**Wilfred C. Bohling** has been named manager of Delta-Star's New York office with **C. F. Bolles** as assistant manager and engineer.

**William H. Homeyer** and **Francis J. Blake** have been named district sales managers for the Carborundum Company. Mr. Homeyer, with headquarters at Los Angeles, has charge of the Southern California area and Mr. Blake, whose headquarters will be in San Francisco, will have charge of the Northern California area. Both have previously represented the Carborundum Company as industrial salesmen in these districts.

**Berton H. DeLong** and **Paul B. Greenawald** are newly appointed directors and vice presidents of the Carpenter Steel Company, Reading, Pennsylvania. In their new posts Mr. DeLong will continue to supervise the research and development work of the company,

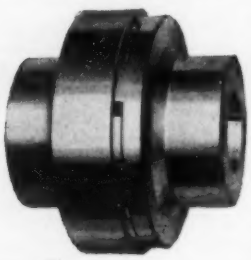
(*Please turn to page 146*)

WANTED: Architectural, mechanical, structural and electrical draftsmen. Men experienced in steel mill construction preferred. Have openings for detailers, designers and checkers. Write, Engineering Department, Great Lakes Steel Corporation, Ecorse, Detroit 18, Michigan.

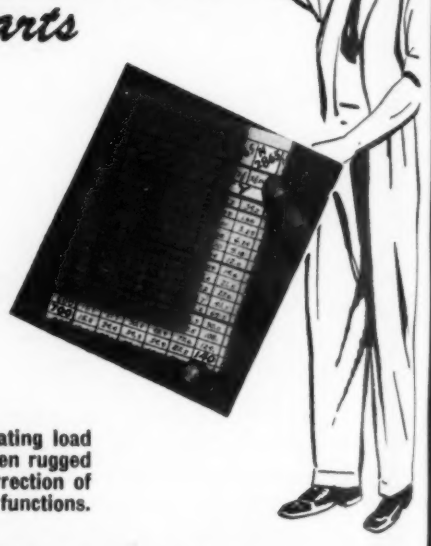




*Simplified Quick-Finding Selector Charts reduce tedious figuring*

With the complete Catalog come new simplified L-R Selector Charts that lead your finger right to the couplings for your duties, cutting out much of the usual figuring. The work is done for you. A Lovejoy contribution to accuracy and time-saving. You will be pleased with the *thoroughness* of these Charts. Have them in your file for ready reference.



*Catalog illustrates and describes couplings for every service and duty to 2500 h. p.*



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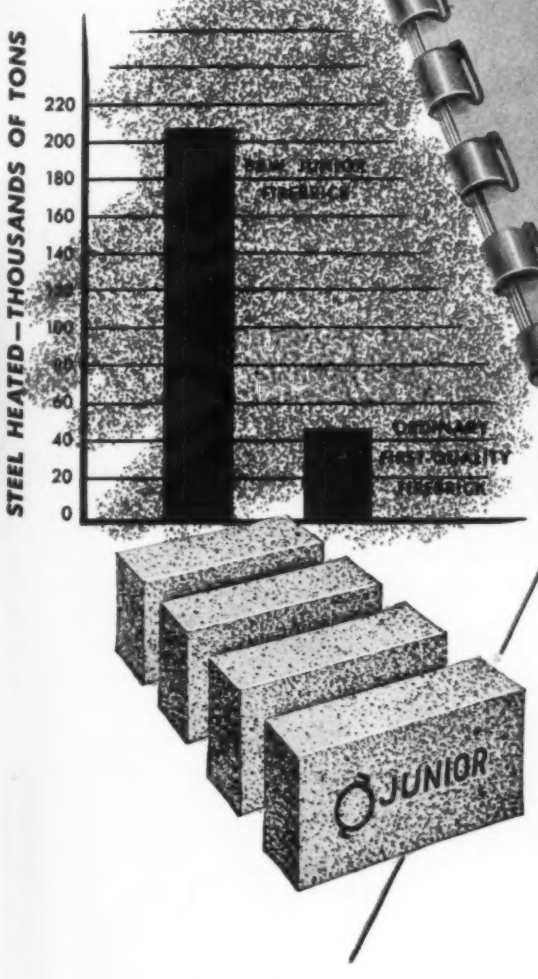
Approx. size: 18' wide, 45' long.
Fuel: Mainly tar, some coke-oven gas end fired.
Billets: Range from 4" to 9" sq.

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In brief, B&W Juniors outlasted fireclay brick about 4.6 to 1.

Thus B&W Junior Firebrick are substantial money savers . . . in the cost of brick per ton of steel heated, in avoiding frequent replacements of fireclay brick, and in eliminating the charges for outages during these replacements.

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*Mr. Harry Dobrin, well-known consultant on combustion problems, is now vice president of Furnace Engineers, Inc.*

and Mr. Greenawald will be in full charge of mill production.

Mr. DeLong has been associated with the company since 1910, holding the post of chief metallurgist since 1916. Before assuming his duties as general superintendent, Mr. Greenawald was metallurgical engineer for the company for 21 years.

**Charles B. Hull** has been made chief draftsman of American Steel and Wire Company, Cleveland, Ohio. Mr. Hull was formerly works engineer at the Cuyahoga works of the company.

**Walter L. Longnecker** has been appointed division metallurgist of hot mills for the American Steel and Wire Company at Cleveland. He comes to the Cleveland office from the rod mills at the Donora, Pennsylvania works of the company.

**Robert V. Lackner** is now connected with the Pittsburgh district office of Allis-Chalmers Manufacturing Company, where he will act as a field engineer, rendering service especially to the steel and alloy industries in the district. He comes to Allis-Chalmers after nine years as an electrical engineer with the Carnegie-Illinois Steel Corporation, Duquesne, Pennsylvania. Previous to that he was associated with the Pennsylvania Railroad Company and engaged in consulting engineering work. He is a graduate of the Carnegie Institute of Technology.

**F. J. Van Poppelen** of Fairfield, Connecticut has been appointed a vice-president of Salem Engineering Company, Salem, Ohio. For the past eleven years, Mr. Van Poppelen has filled various executive positions at the Remington Arms Company of Bridgeport, Connecticut. During the last several years, he served as chief engineer of the Military Division for the same company.

## *Obituary*

**William H. Fitch,** president of Fitch Recuperator Company, Plainfield, New Jersey, died recently. Mr. Fitch pioneered in the development and application of tubular silicon carbide recuperators for The Carborundum Company, Niagara Falls, New York, and later took over this branch of the business as his own company, which will continue under the management of his son, **William H. Fitch, Jr.**

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The component parts of this bearing are freely interchangeable. That is any inner race will fit any roller assembly of the same piece number—thus facilitating product assembly and disassembly. This bearing like the other separable inner race bearings in the Hyatt Hy-Load line can be used with the inner race omitted and the rollers operated directly on a hardened and ground shaft.

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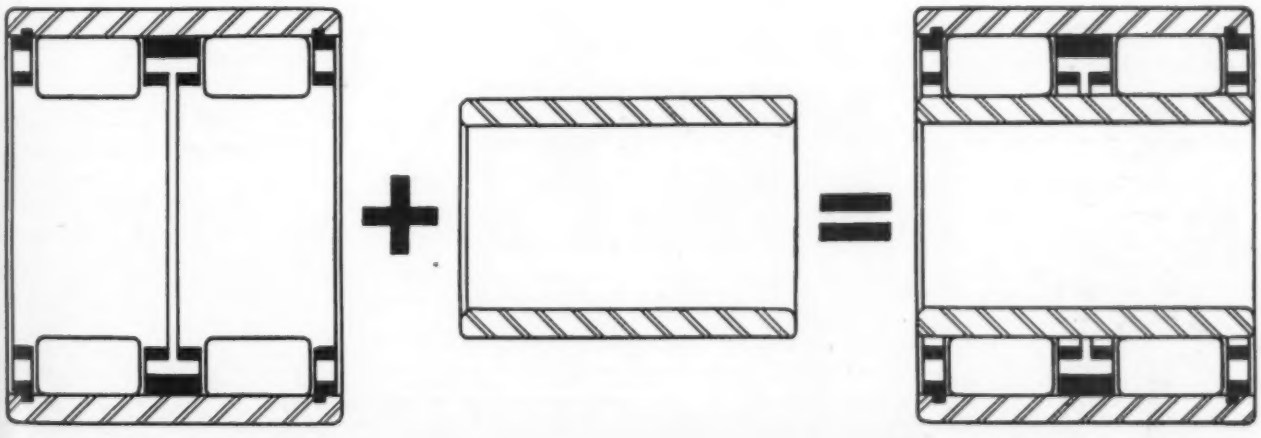

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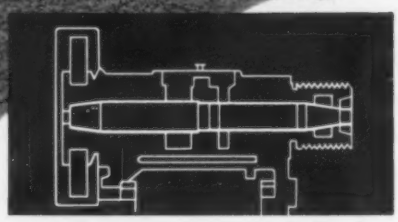

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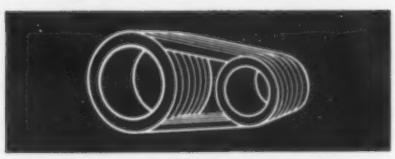

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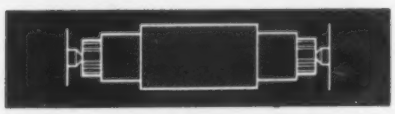

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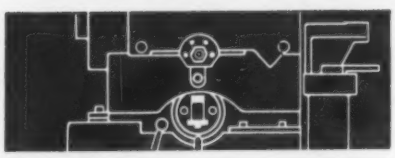

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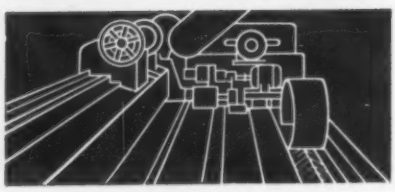

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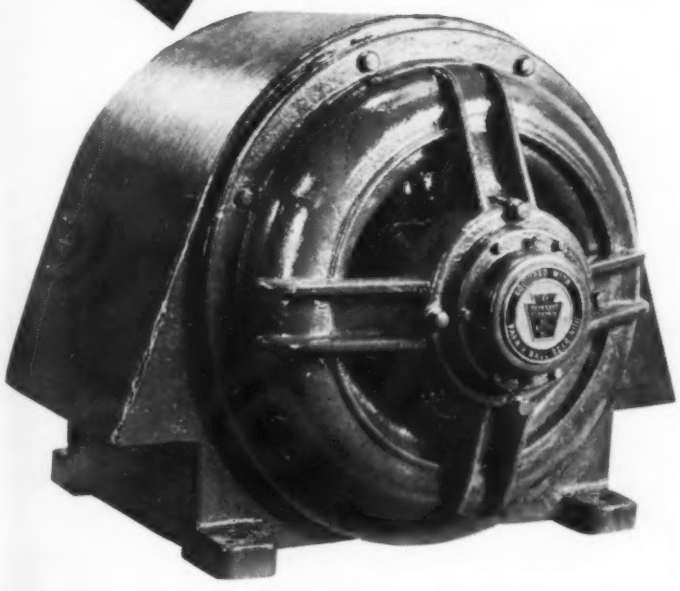

An electric motor must be cooled by air . . . If that air is filled with dirt and dust then motor performance suffers and maintenance costs soar — but *not* if the motor is equipped with the Keystone, *grease-packed ball bearing* End Bell.

No lubricating oil from the sleeve bearing can catch and hold the dirt as it passes through the motor. No oil vapor from the bearing housing is sprayed over the coils or clogs the ventilating passages until the motor's temperature rises, and its life is shortened.

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*Modern Steel Mill Lubricant*

*Better Lubrication at Less Cost per Month*



# OHIO

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**A standard 65" Ohio Magnet Lifting 5200 lbs. of Pig Iron**

**Standard round general purpose Ohio magnets are built in sizes from 12" to 65" in diameter.**

**Average lifting capacity for pig iron or scrap ranges from 200 lbs. to 6200 lbs.**

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**THE OHIO ELECTRIC MFG. COMPANY**

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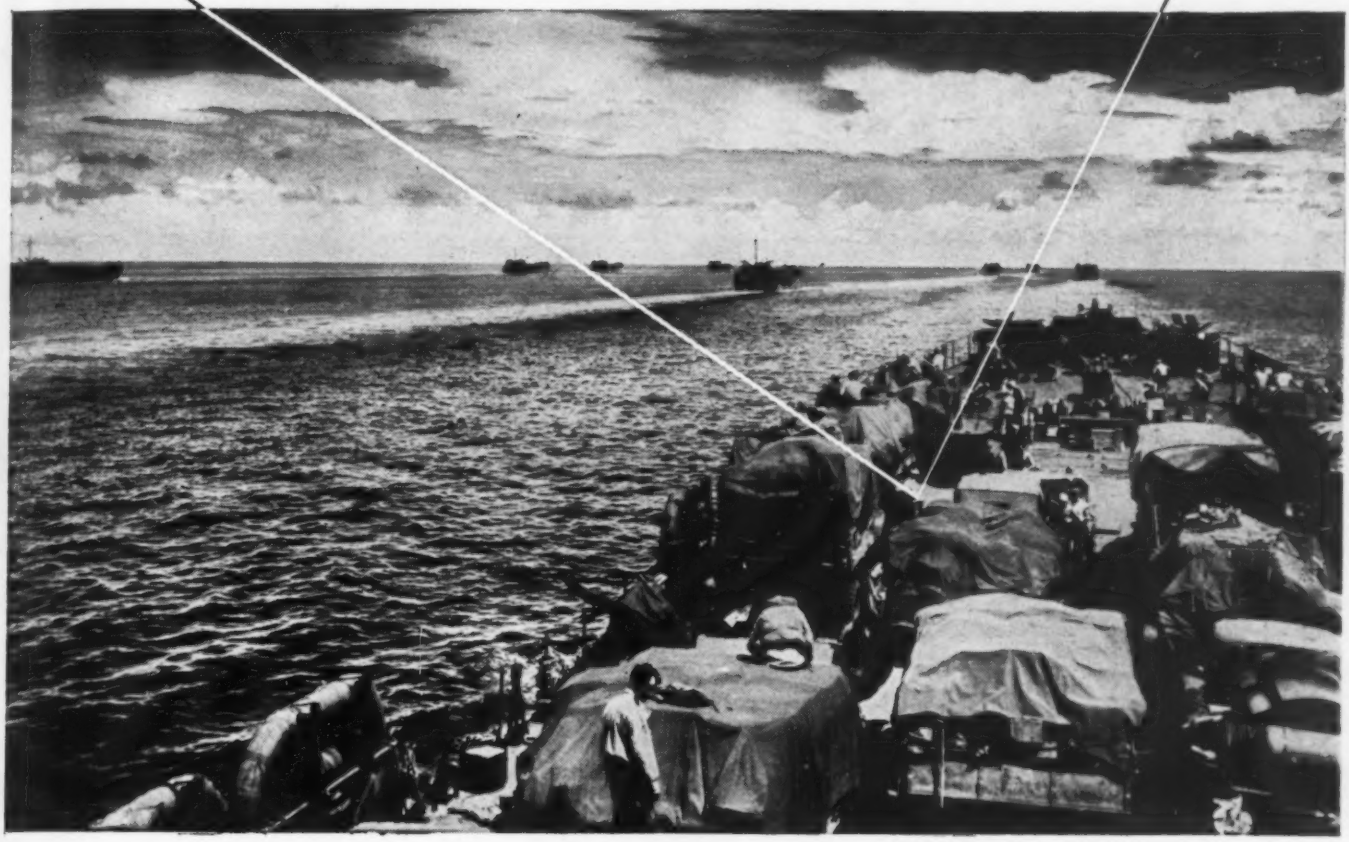
*On their Way again to Win again!*



# Are You?

**Today** the veterans of our European victories are sailing to final triumph in the Pacific! Meanwhile patriotic American industrial leaders are following a full-speed-ahead program to hasten peace through the Payroll Savings Plan!

From coast to coast, veteran Bond salesmen—and women—who put over the Mighty 7th, are once more mustered into service for plantwide selective resolicitation campaigns. These special efforts to keep employee Bond buying at a maximum are directed toward two major objectives:

**A** To hold every new 7th War Loan subscriber on the Payroll Savings Plan books—maintaining and, wherever possible, increasing present Bond allotments.

**B** To convince all regular subscribers who recently stepped up their Bond buying, of the many advantages of continuing on this foresighted, extra-Bonds-for-the-future basis.

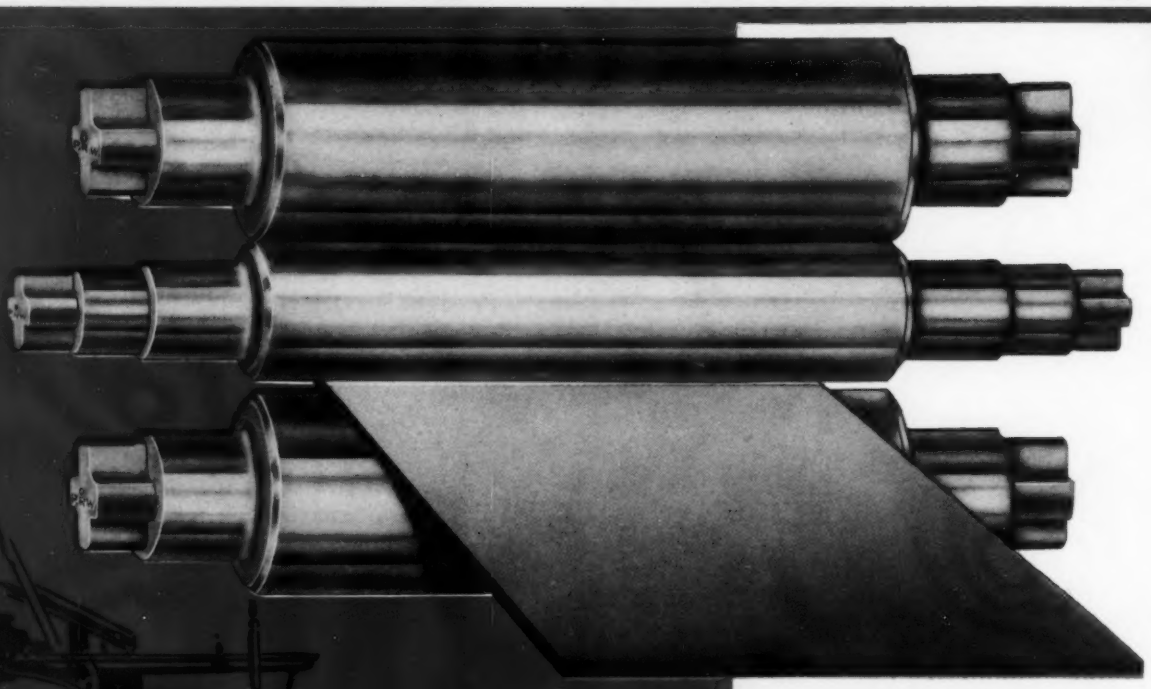
Back up our fighting men who have won one war—and will win another. Use selective resolicitation to make your Payroll Savings Plan more effective—put a tighter rein on inflationary tendencies—build peacetime prosperity.

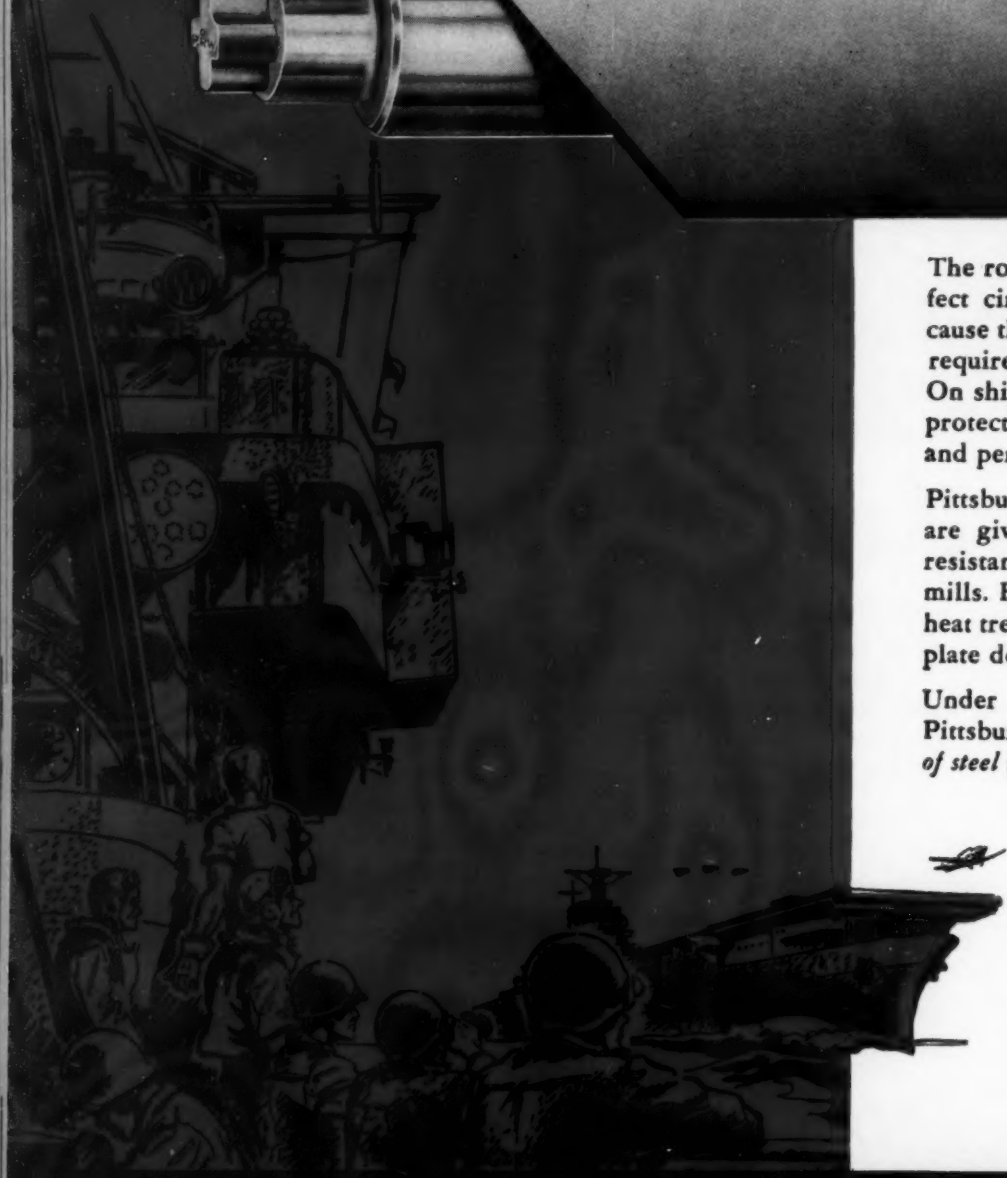
*The Treasury Department acknowledges with appreciation the publication of this message by*

*IRON AND STEEL ENGINEER*

★ *This is an official U. S. Treasury advertisement prepared under the auspices of Treasury Department and War Advertising Council* ★

# PLATE ROLLING TECHNIQUE





The rolling of plate is like drawing a perfect circle free-hand . . . it looks easy because the shape is simple. But plate rolling requires the highest skill *and perfect rolls.* On ships and tanks and planes, steel plate protects vital control points, ammunition and personnel.

Pittsburgh 25 Grain Type Alloy Iron Rolls are giving excellent tonnages with high resistance to spalling in three-high plate mills. For floor plates, a special alloy steel heat treated roll is used because of the floor plate design that must be cut into the roll.

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**Division of Blaw-Knox Company**
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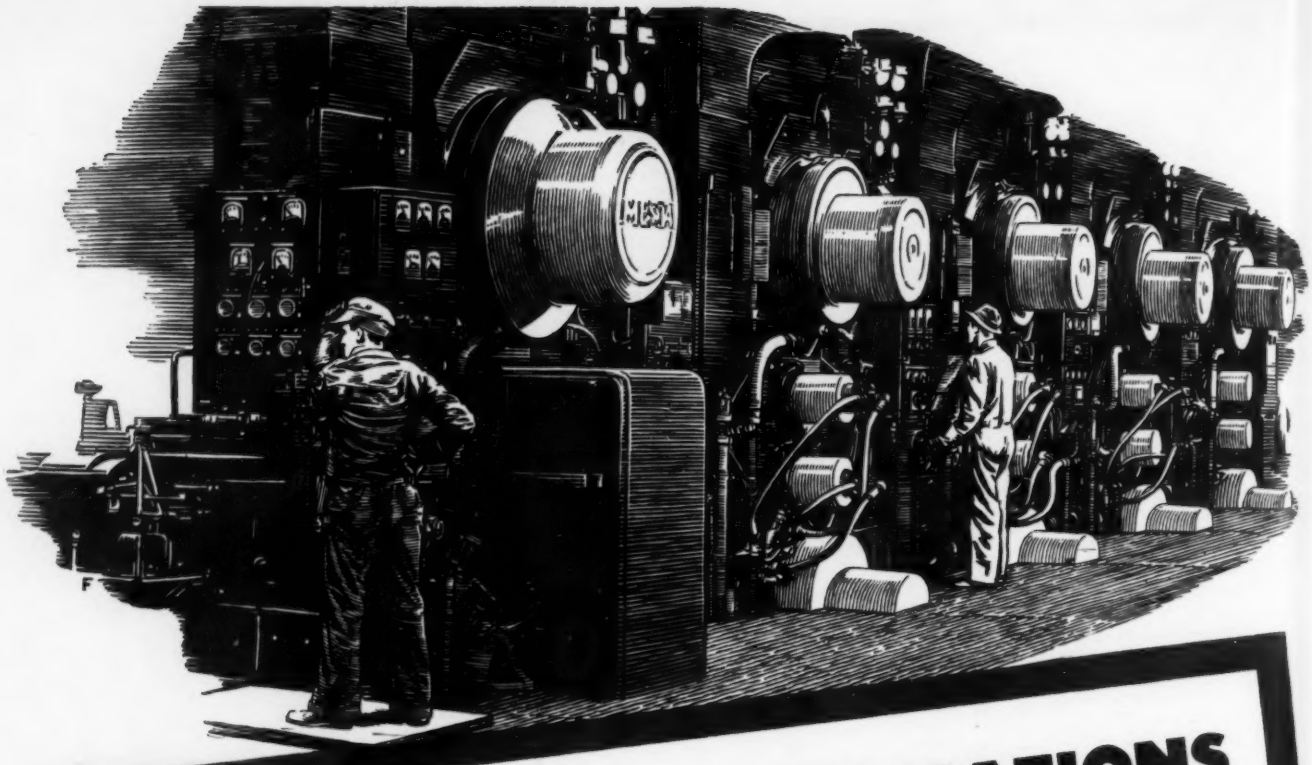
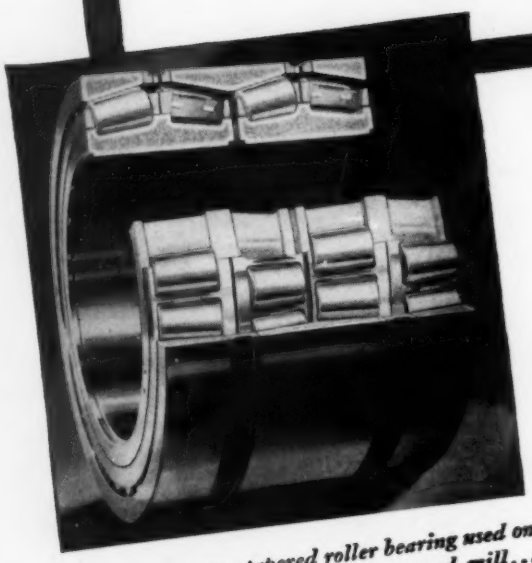


# FOR ROLL NECK APPLICATIONS

## ...AND OTHER HEAVY-DUTY JOBS



*Torrington 4-row tapered roller bearing used on the roll necks of the Mesta five stand mill... 12" bore by 17¼" O.D.*

The mill you see above delivers 3200 feet of cold strip per minute. That means high R.P.M. on the roll necks... speeds and heavy loads handled efficiently by Torrington 4-row tapered roller bearings. Made of S.A.E.-3310 steel (with higher nickel content) for maximum service life, the bearings have the additional advantage of simple design.

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In the competitive days coming, you should be "backed up" with that kind of performance from *your* steel mill equipment. For maximum roll neck diameters, bearings of all tapered types can be supplied with proportioned cross-section. And our engineers will gladly help yours to incorporate Torrington Bearing advantages in your designs.

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**SOUTH BEND 21, INDIANA**

# TORRINGTON BEARINGS

**STRAIGHT ROLLER · TAPERED ROLLER · NEEDLE · BALL**

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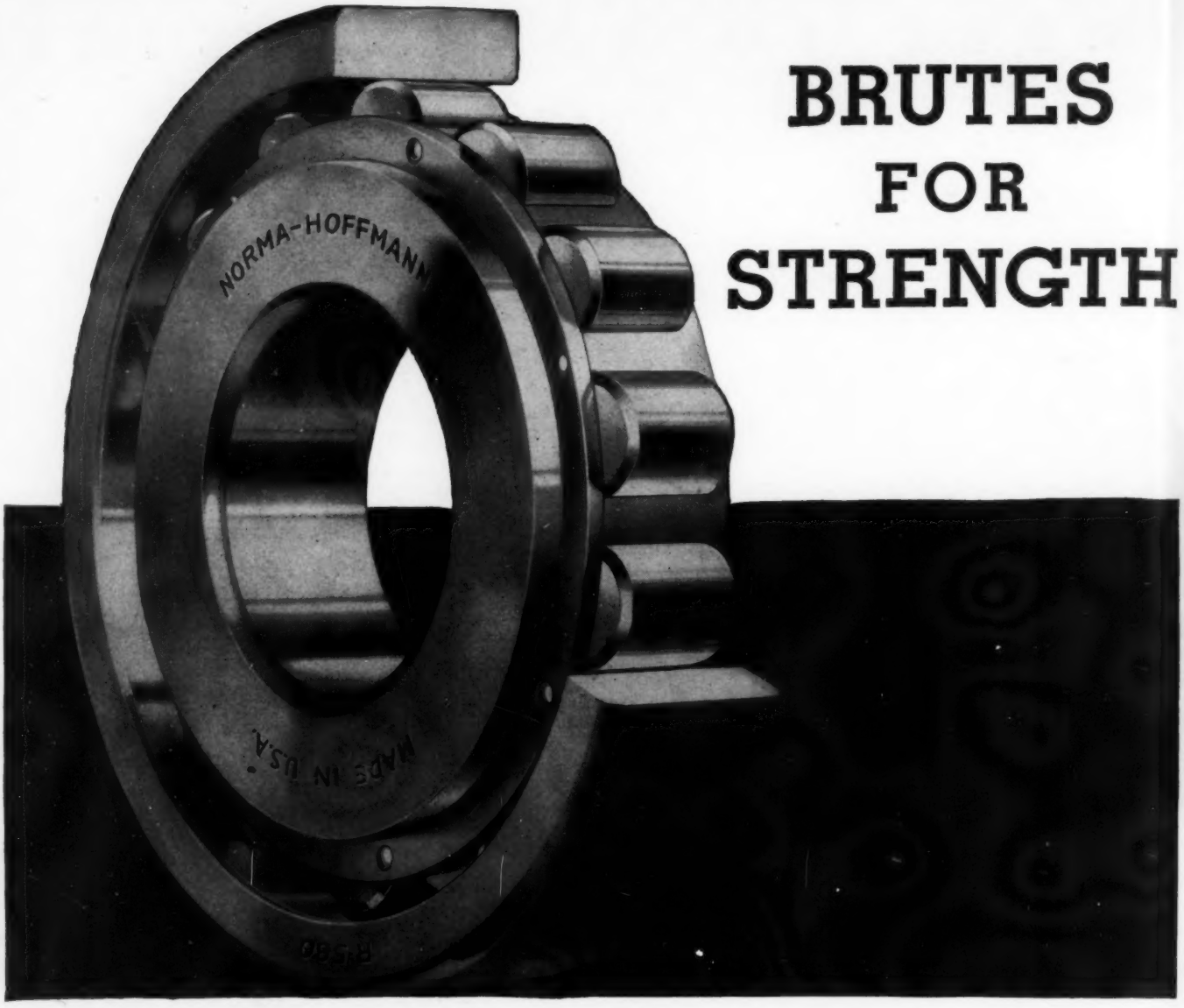


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THE outstanding performance records made by NORMA-HOFFMANN PRECISION ROLLER BEARINGS under the heaviest and most exacting duties, are the logical result of the following distinctive factors:

Full line contact of rolling surfaces, affording a larger radial load capacity for continuous and intermittent service than any other type of single-row bearing, and providing a temporary overload capacity 50% above normal catalog rating, with greater resistance to shock and vibration.

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Test these PRECISION ROLLER BEARINGS in your own hardest service; remember that they have all the high speed qualities of the best ball bearings, and are interchangeable, size for size, with all single-row metric ball bearings.

*Write for the catalog. Let our engineers work with you.*

"NORMA-HOFFMANN"

PRECISION BALL, ROLLER and THRUST BEARINGS

NORMA-HOFFMANN BEARINGS CORPN., STAMFORD, CONN. U.S.A.

# "Clevelands' Performance Sold Us SPEEDAIRE"

## A Plant Engineer writes:—

"Cleveland Worm Gear Drives are old friends—so naturally we are 'pleased to meet' your new Speedaire Fan-cooled Unit. Since 1923 we have accepted your engineering recommendations—have installed Cleveland Worm Gear Speed Reducers on all of our heavy equipment carrying 24-hour loads.

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**Interesting Catalog 300 is complete with engineering tables and fully illustrated. May we send it?**

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*In Canada: Peacock Brothers, Limited*

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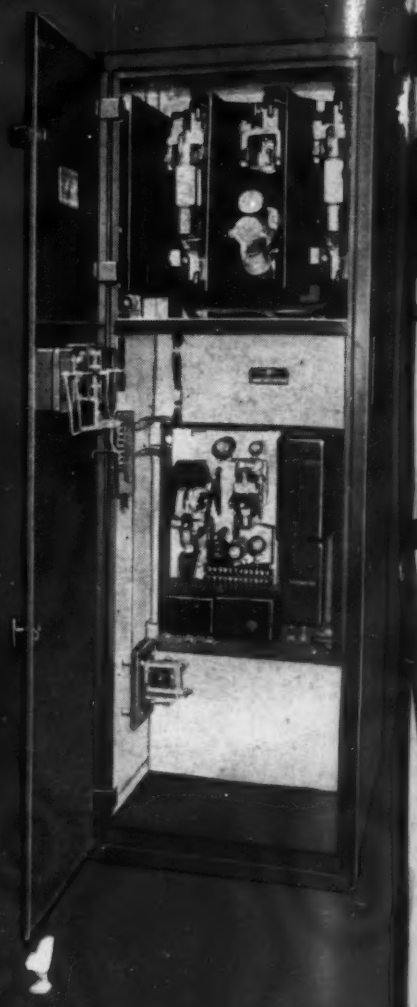
*Cleveland* **SPEEDAIRE** *Worm Gear Reduction Units*
FAN COOLED

# HOW LIMITAMP CONTROL PROTECTS YOUR MOTOR



## 1/2-CYCLE OPERATION clears high-voltage fault currents before they can do harm

LIMITAMP control, for use with squirrel-cage, synchronous, and wound-rotor motors, provides fast, positive short-circuit protection so necessary for safe operation at high voltages.

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### A Co-ordinated Control

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On voltages up to 4200 volts, the interrupting capacity of Limitamp control makes it the logical answer for any application where high-voltage fault currents are encountered.

Buy all the BONDS you can—and *keep all you buy*

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